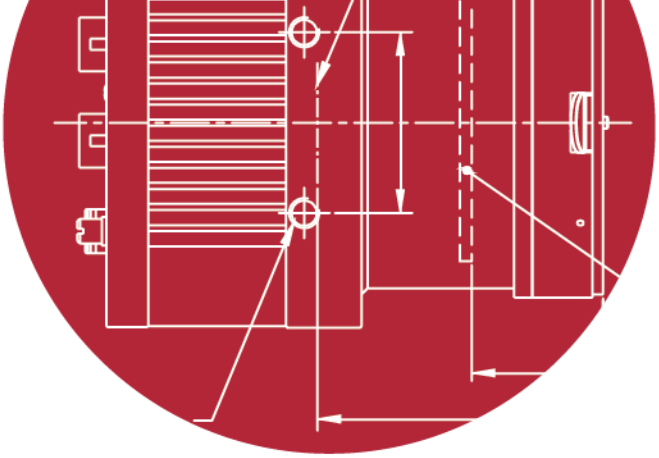


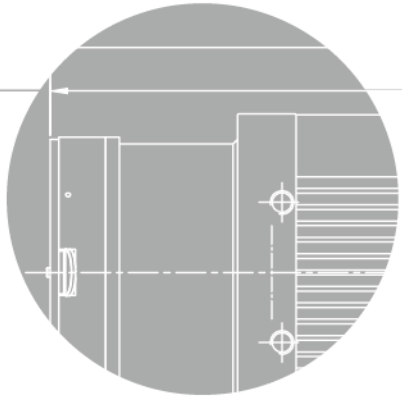
VNP series

User Manual

English

VNP-29MC-5

CAMERA Link



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Revision History

Version	Date	Description
1.0	2013-04-11	Initial Release
1.1	2013-06-14	• Added description of M5 set screws for tilt adjustment • Revised spectral response according to the updated TSI datasheets • Added Actual Time Applied for Commands • Removed the Horizontal Flip feature
1.2	2013-08-21	Added DSNU Correction feature
1.3	2014-09-19	Applied new CI

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1 Precautions

General

- Do not drop, disassemble, repair or alter the device. Doing so may damage the camera electronics and cause an electric shock.
- Do not let children touch the device without supervision.
- Stop using the device and contact the nearest dealer or manufacturer for technical assistance if liquid such as water, drinks or chemicals gets into the device.
- Do not touch the device with wet hands. Doing so may cause an electric shock.
- Do not store the device at a higher temperature. In addition, maintain the temperature of the camera housing in a range of 10℃ to 40℃ during operation. Otherwise the device may be damaged by excessively high temperatures.

Installation and Maintenance

- Do not install in dusty or dirty areas - or near an air conditioner or heater to reduce the risk of damage to the device.
- Avoid installing and operating in an extreme environment where vibration, heat, humidity, dust, strong magnetic fields, explosive/corrosive mists or gases are present.
- Do not apply excessive vibration and shock to the device. This may damage the device.
- Avoid direct exposure to a high intensity light source. This may damage the image sensor.
- Do not install the device under unstable lighting conditions. Severe lighting change will affect the quality of the image produced by the device.
- Do not use solvents or thinners to clean the surface of the device. This can damage the surface finish.

Power Supply

- Applying incorrect power can damage the camera. If the voltage applied to the camera is greater or less than the camera's nominal voltage, the camera may be damaged or operate erratically. Please refer to 5.2 Specifications for the camera's nominal voltage.
  ※ Vieworks Co., Ltd. does NOT provide power supplies with the devices.
- Make sure the power is turned off before connecting the power cord to the camera. Otherwise, damage to the camera may result.

2 Warranty

Do not open the housing of the camera. The warranty becomes void if the housing is opened.
For information about the warranty, please contact your local dealer or factory representative.

3 Compliance & Certifications

3.1 FCC Declaration

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expenses.

3.2 CE : DoC

EMC Directive 2004/108/EC.
Testing Standard EN 55022:2006+A1:2007, EN 55024:1998+A1:2001+A2:2003
Class A

3.2.1 KCC Statement

Type	Description
Class A (Broadcasting Communication Device for Office Use)	This device obtained EMC registration for office use (Class A), and may be used in places other than home. Sellers and/or users need to take note of this.

4 Package Components

Package Components

VNP Camera (F-Mount)

Mount Plate (Optional)

M5 Set Screws for Tilt Adjustment (Provided only with F-mount camera)

CAUTION	• You can adjust the tilt using the M5 set screws, however it is not recommended since it is adjusted as factory default settings. • If the tilt settings need to be adjusted inevitably, please contact your local dealer or factory representative for technical support.

5 Product Specifications

5.1 Overview

The VNP Camera Link series, pixel shift camera equipped with thermo-electric Peltier (TEC) cooled, is designed not only for applications where extremely high resolution is required but also where high quality image is essential. The TEC maintains the operating temperature of the CCD at up to 15 degrees below ambient temperature to reduce noise significantly. Pixel shift technology based on a precise piezoelectric stage allows image captures as high as 260 million pixels using the VNP-29MC cameras.
These cameras are ideal for applications such as FPD inspection, document/film scanning, research and scientific imaging.

Main Features

- Nano Stage Pixel Shift Mechanism
- Thermoelectric Peltier Cooled
- Extended Resolutions up to 260 megapixels
- True Color Full Image Resolution
- Improved Fill Factor
- Progressive Scan Interline Transfer CCD Imager
- Flat Field Correction
- Field Upgradable Firmware
- Pixel Defect Correction
- Area Of Interest (AOI)
- Binning Mode – 2 × 2 / 4 × 4
- Output Pixel Format – 8 / 10 / 12 bit
- Output Channel – 1 Tap / 2 Tap / 4 Tap
- Auto Taps Adjustment
- Electronic Shutter
- Strobe Output
- Analog Gain/Offset adjustment function
- Look Up Table
- Test Image
- Temperature Monitor
- Base Camera Link

5.2 Specifications

VNP Series		VNP-29MC
Active Image (H × V)		6576 × 4384
Sensor Type		Truesense Imaging KAI-29050
Pixel Size		5.5 μm × 5.5 μm
Sensor Output		1 or 2 Tap Output
Video Output		8/10/12 bits, 1 or 2 Tap
Camera Interface		Camera Link (Base)
Electronic Shutter		Global Shutter
Max. Frame Rate at Resolution	×1 (1 Shot)	5 fps @ 28.8 M (6576 × 4384)
	×4 (4 Shot)	1.3 fps @ 115.3 M (13152 × 8768)
	×9 (9 Shot)	0.6 fps @ 259.5 M (19728 × 13152)
Data Output Pixel Clock Speed		40/80 MHz
Exposure Time		1/100000 sec ~ 7 sec (10 μs step)
Partial Scan (Max. Speed)		16 fps at 1000 Lines
Gamma Correction		User defined LUT (Look Up Table)
Black Offset		Adjustable (0~127 LSB at 12 bits, 256 step)
Video Gain		Analog Gain: 0 ~ 32 dB, 900 step
Trigger Mode		Mode(Free-Run , Overlap, Fast, Double), Programmable exposure time and trigger polarity
External Trigger		External, 3.3 V - 5.0 V, 10 mA, optically isolated
Software Trigger		Camera Link CC1, Programmable Exposure
Dynamic Range		>62 dB
Control		RS-232C via Camera Link (115.2 K bps)
Shift Range		0 ~ 15 μm, 1 nm step
Shift Resolution		0.001 μm
Shift Control		Manual Mode or Sequence Mode (4/9 Shot Mono, 4/16/36 Shot Color)
Shift Latency		< 8 ms
Cooling Method		Thermoelectric Peltier Cooling
Cooling Performance		15℃ below ambient temperature – Standard cooling with a fan
Lens Mount		F-mount
Power		10~14 V DC, Max. 32 W
Environmental		Operating: 10℃ ~ 40℃, Storage: -40℃ ~ 70℃
Dimension (W×H×L) / Weight		94 mm × 120 mm × 181.5 mm, 2.3 kg

Table 5.1 Table 5.1 Specifications of VNP 29MC

5.3 Camera Block Diagram

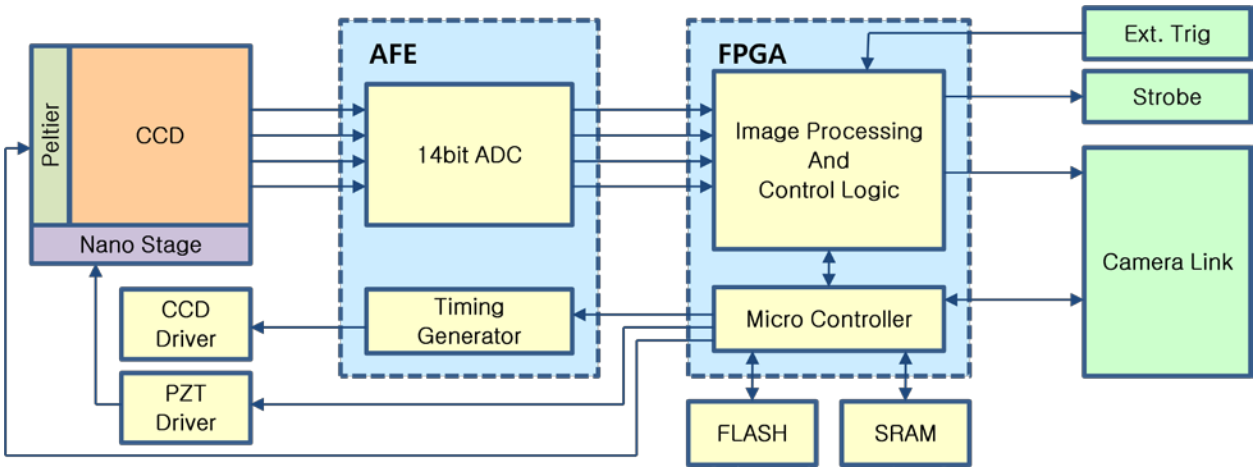


Figure 5.1 VNP Camera Block Diagram

All controls and data processing of VNP cameras are carried out in one FPGA chip. The FPGA generally consists of a 32 bit RICS Micro-Controller and Processing & Control Logic. The Micro-Controller receives commands from the user through the Camera Link interface and then processes them. The FPGA controls the Timing Generators (TGs) and the Analog Front End (AFE) chips where the TGs generate CCD control signals and AFE chips convert analog CCD output to digital values to be accepted by the Processing & Control Logic. The Processing & Control Logic processes the image data received from AFE and then transmits data through the Camera Link interface. And also, the Processing & Control Logic controls the trigger inputs and strobe outputs which are sensitive to time. Furthermore, SDRAM and FLASH is installed outside FPGA. SDRAM is used for the frame buffer to process images and FLASH contains the firmware that operates the Micro-Controller. And, PZT Driver is applied to control XY Stage with nanometers unit and Peltier Driver is applied to control Thermoelectric Peltier Cooling unit.

5.4 Spectral Response

The following graphs show the spectral response for VNP monochrome and color cameras.

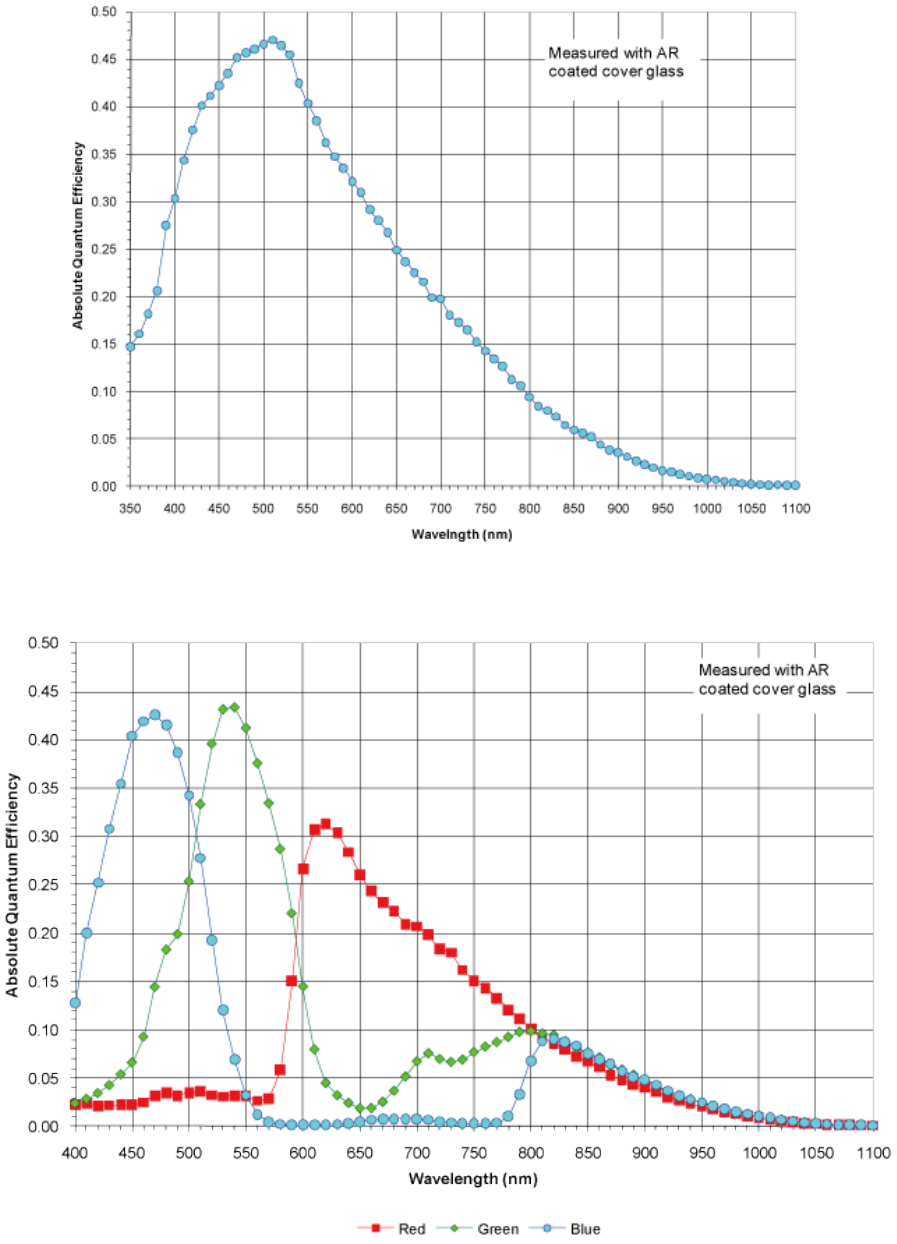


Figure 5.2 VNP-29MC Spectral Response (Top: Monochrome, Bottom: Color)

5.5 Mechanical Specification

The camera's dimensions in millimeters are as shown in the following figure.

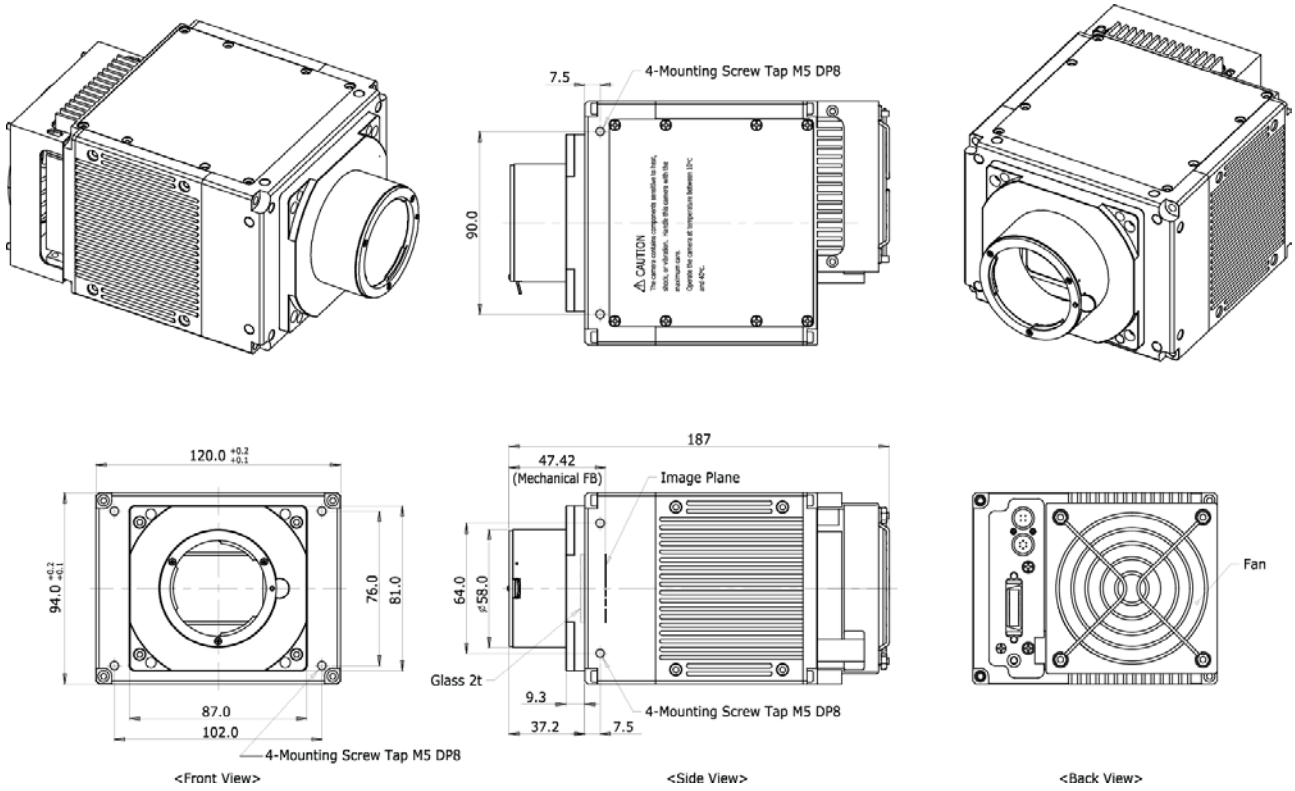


Figure 5.3 VNP Camera Link Mechanical Dimension (F-Mount)

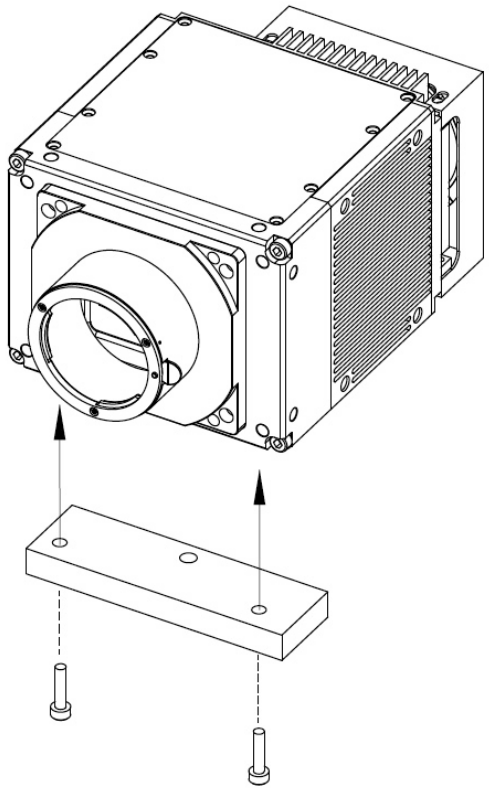
6 Connecting the Camera

The following instructions assume that you have installed a Camera Link frame grabber in your PC including related software. For more information, refer to your Camera Link frame grabber User Manual.

To connect the camera to your PC, follow the steps below:

1. Make sure that the power supply is not connected to the camera and your PC is turned off.
2. Plug one end of a Camera Link cable into the Camera Link connector on the camera and the other end of the Camera Link cable into the connector on your Camera Link frame grabber.
3. Connect the plug of the power adaptor to the power input connector on the camera.
4. Plug the power adaptor into a working electrical outlet.
5. Verify all the cable connections are secure.

6.1 Mount Plate



- The Mount Plate is provided as an optional item.
- The camera can be fixed without using this Mount Plate.

6.2 Precaution to center the image sensor

- User does not need to center the image sensor as it is adjusted as factory default settings.
- When you need to adjust the center of image sensor, please contact your local dealer or the manufacturer for technical assistance.

6.3 Precaution about blurring compared to center

- User does not need to adjust the tilt as it is adjusted as factory default settings.
- If the tilt settings need to be adjusted inevitably, please contact your local dealer or factory representative for technical support.

6.4 Installing the Configurator

- You can control the camera by executing the Configurator.exe file.
- You can download the latest Configurator at machinevision.vieworks.com.
- For more information, refer to your Grabber User Manual.

7 Camera Interface

7.1 General Description

As shown in the following figure, 3 types of connectors and status indicator LED are located on the back of the camera and have the functions as follows:

- ① 4 pin Control Receptacle: inputs external trigger signal and outputs strobe.
- ② 6 pin Power Input Receptacle: supplies power to the camera.
- ③ 26 pin Camera-Link Connector: controls video data transmission and the camera.
- ④ Status LED: displays power status and operation mode.

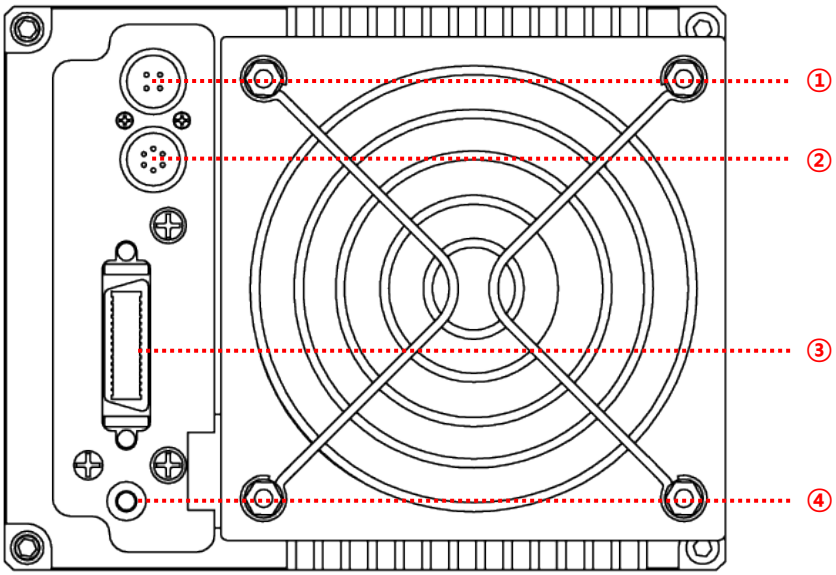


Figure 7.1 VNP Series Back Panel

7.2 Camera Link Connector

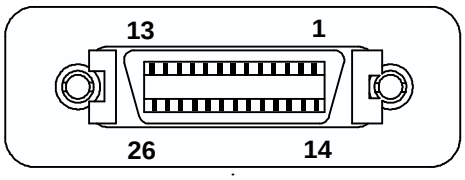


Figure 7.2 Camera Link Connector

Camera Link connector complies with Camera Link Standard and the following list shows the pin configuration of the connector.

PAIR List	Pin	Signal Name	Type	Description
PAIR 0	1	Ground	Ground	Cable Shield
	14	Ground	Ground	Cable Shield
PAIR 1	2	-X0	LVDS - Out	Camera Link Transmitter
	15	+X0	LVDS - Out	Camera Link Transmitter
PAIR 2	3	-X1	LVDS - Out	Camera Link Transmitter
	16	+X1	LVDS - Out	Camera Link Transmitter
PAIR 3	4	-X2	LVDS - Out	Camera Link Transmitter
	17	+X2	LVDS - Out	Camera Link Transmitter
PAIR 4	5	-X3	LVDS - Out	Camera Link Transmitter
	18	+X3	LVDS - Out	Camera Link Transmitter
PAIR 5	6	-XCLK	LVDS - Out	Camera Link Transmitter
	19	-XCLK	LVDS - Out	Camera Link Transmitter
PAIR 6	7	- SerTC	LVDS - In	Serial Data Receiver
	20	+ SerTC	LVDS - In	Serial Data Receiver
PAIR 7	8	- SerTFG	LVDS - Out	Serial Data Transmitter
	21	+ SerTFG	LVDS - Out	Serial Data Transmitter
PAIR 8	9	- CC 1	LVDS - In	Software External Trigger
	22	+ CC 1	LVDS - In	Software External Trigger
PAIR 9	10	N/C	N/C	N/C
	23	N/C	N/C	N/C
PAIR 10	11	N/C	N/C	N/C
	24	N/C	N/C	N/C
PAIR 11	12	N/C	N/C	N/C
	25	N/C	N/C	N/C
PAIR 12	13	Ground	Ground	Cable Shield
	26	Ground	Ground	Cable Shield

Table 6.1 Pin Assignments for Camera Link Base Configuration

7.3 Power Input Receptacle

The power input receptacle is a Hirose 6 pin connector (part # HR10A-7R-6PB). Pin arrangement and configuration are as follows:

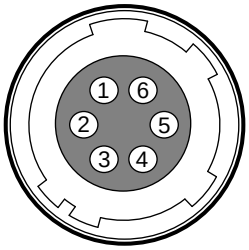


Figure 7.3 Pin Arrangement of Power Input Receptacle

Pin Number	Signal	Type	Description
1, 2 , 3	+ 12 V DC	Input	DC Power Input
4 , 5 , 6	DC Ground	Input	DC Ground

Table 6.2 Pin Configuration of Power Input Receptacle

Connecting the power cable to the camera can be made by using the Hirose 6 pin plug (part # HR10A-7P-6S) or the equivalent. The power adaptor is recommended to have at least 1A current output at 12 V DC ±10% voltage output (Users need to purchase the power adaptor separately).

Precaution for Power Input

CAUTION

- Make sure the power is turned off before connecting the power cord to the camera. Otherwise, damage to the camera may result.
- If the camera input voltage is greater than specified input voltage range, damage to the camera may result.

7.4 Control Receptacle

The control receptacle is a Hirose 4 pin connector (part # HR10A-7R-4S) and consists of external trigger signal input and strobe output ports. The pin arrangement and configuration are as follows:

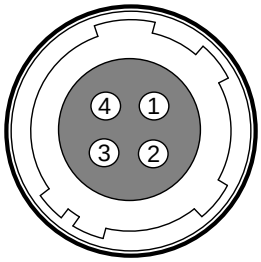


Figure 7.4 Pin Arrangement of Control Receptacle

Pin Number	Signal	Type	Description
1	Trigger Input +	Input	-
2	Trigger Input -	Input	-
3	DC Ground	-	DC Ground
4	Strobe Out	Output	3.3 V TTL Output Output resistance : 47 Ω

Table 6.3 Pin Arrangement of Control Receptacle

The mating connector is a Hirose 4 pin plug (part # HR10A-7P-4P) or the equivalent connectors.

7.5 Trigger Input Circuit

Following figure shows trigger signal input circuit of the 4-pin connector. Transmitted trigger signal is applied to the internal circuit through a photo coupler. Minimum trigger width that can be recognized by the camera is 1 μs. If transmitted trigger signal is less than 1 μs, the camera will ignore the trigger signal. External trigger circuit example is shown below.

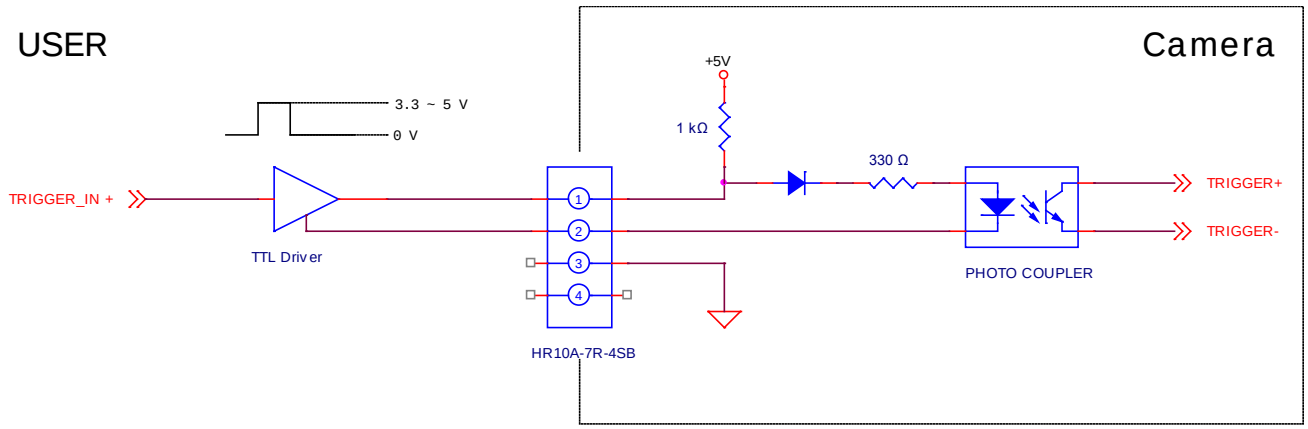


Figure 7.5 Trigger Input Schematic

7.6 Strobe Output Circuit

The strobe output signal is 3.3 V output level of a TTL Driver IC. The pulse width of signal is synchronized with the exposure signal (shutter) of the camera.

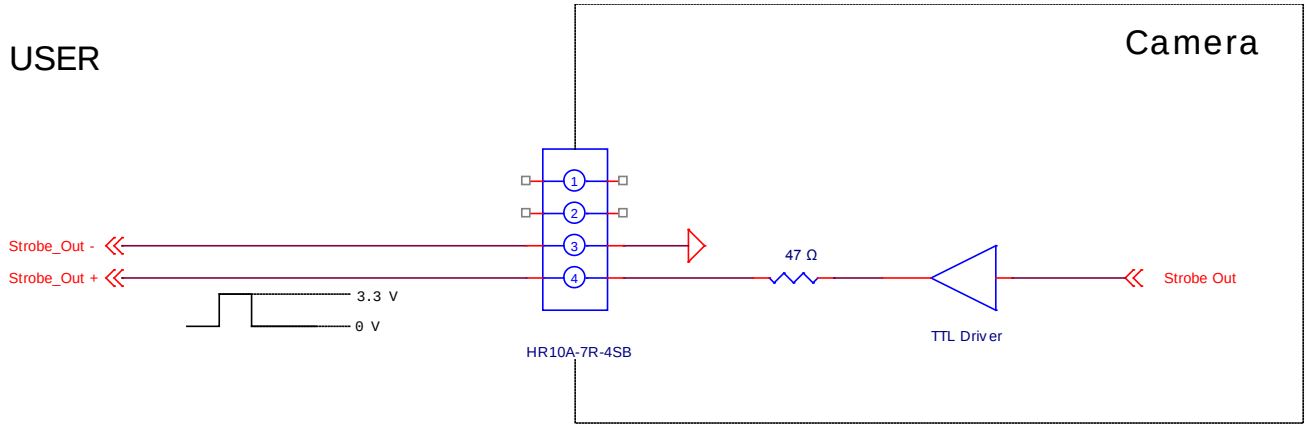


Figure 7.6 Strobe Output Schematic

8 Camera Features

8.1 Area Of Interest (AOI)

The Area of Interest (AOI) feature allows you to specify a portion of the sensor array. You can acquire only the frame data from the specified portion of the sensor array while preserving the same quality as you acquire a frame from the entire sensor array. AOI is determined as the overlapping area of two areas when designating start point and end point in horizontal and vertical direction as shown in figure below. Start point and End point mean the starting and end of the AOI. According to characteristics of the sensor structure, readout of the image will be proceeded at the top and bottom simultaneously. If the Channel mode is set to 4 Tap and Vertical AOI is applied, V End will be ignored because V End is defined by V Start. The actual V End will be applied according to the following formula:

```
V End = (VSIZE – V Start) - 1
```

The narrower Vertical AOI is designated, the faster the frame speed will be. However Horizontal AOI does not affect the frame speed. For more information about AOI parameter settings, see “sha” and “sva” command on Command List.

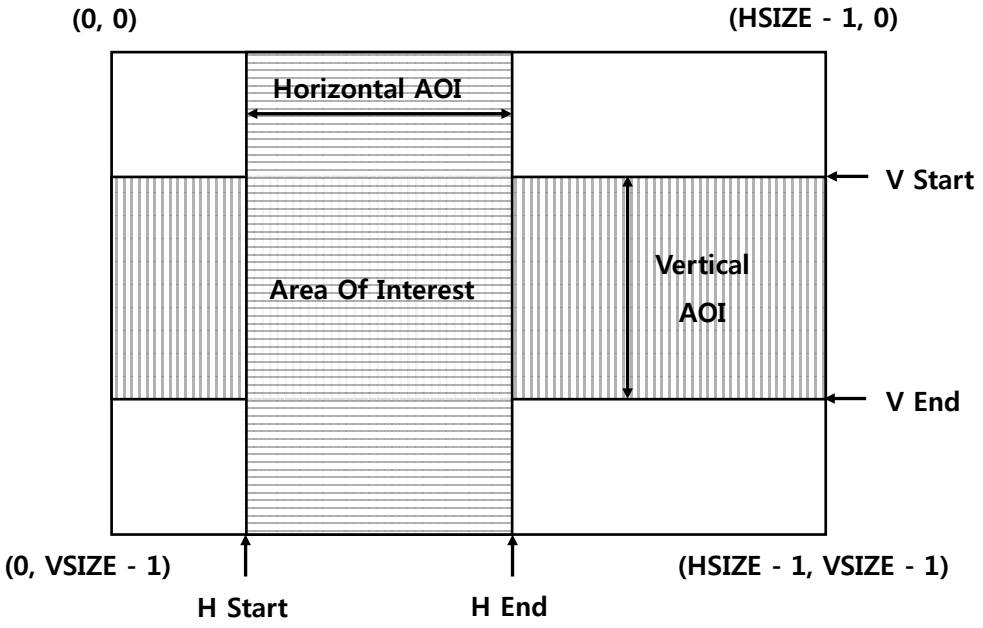


Figure 8.1 Area of Interest

CAUTION

The AOI values (H × V) may vary depending on the type of frame grabber.
For technical assistance, contact to your local dealer or the manufacturer.

The approximate maximum frame rate depending on the change of Vertical AOI can be obtained as shown in the following expression.

1 or 2 Channel Mode:

$$\text{Frame Rate(fps)} = 1000000 / [T_{VCCD} + T_{RF} \times \{V_{SIZE} - (V_{AOI} + 12)\} + (V_{AOI} + 12) \times T_L]$$

4 Channel Mode:

$$\text{Frame Rate(fps)} = 1000000 / [T_{VCCD} + T_{RF} \times \{V_{SIZE} - (V_{AOI} + 12)\}/2 + \{(V_{AOI} + 12) \times T_L\}/2]$$

T_{VCCD}: time required to move electric charges accumulated on pixel to Vertical Register

T_{RF}: time required for Fast Dump

V_{SIZE}: number of Vertical Line of CCD

T_L: time required for transmission of one line

V_{AOI}: size of Vertical AOI

The available minimum value of T_{VCCD}, T_{RF}, V_{SIZE}, T_L and V_{AOI} may vary depending on the camera model. The value of T_L may vary depending on the channel mode. The values of each item are shown below.

VNP Series	VNP-29MC
T_{VCCD}	56.3 μs
T_L (1 channel)	172.3 μs
T_L (2 channel)	90.125 μs
T_L (4 channel)	90.125 μs
T_{RF}	6.8 μs
V_{SIZE}	4384 Lines
Minimum Vertical AOI Size	500 Lines

Table 7.1 Timing Value for VNP-29MC

The following figure shows frame rate depending on VAOI changes.

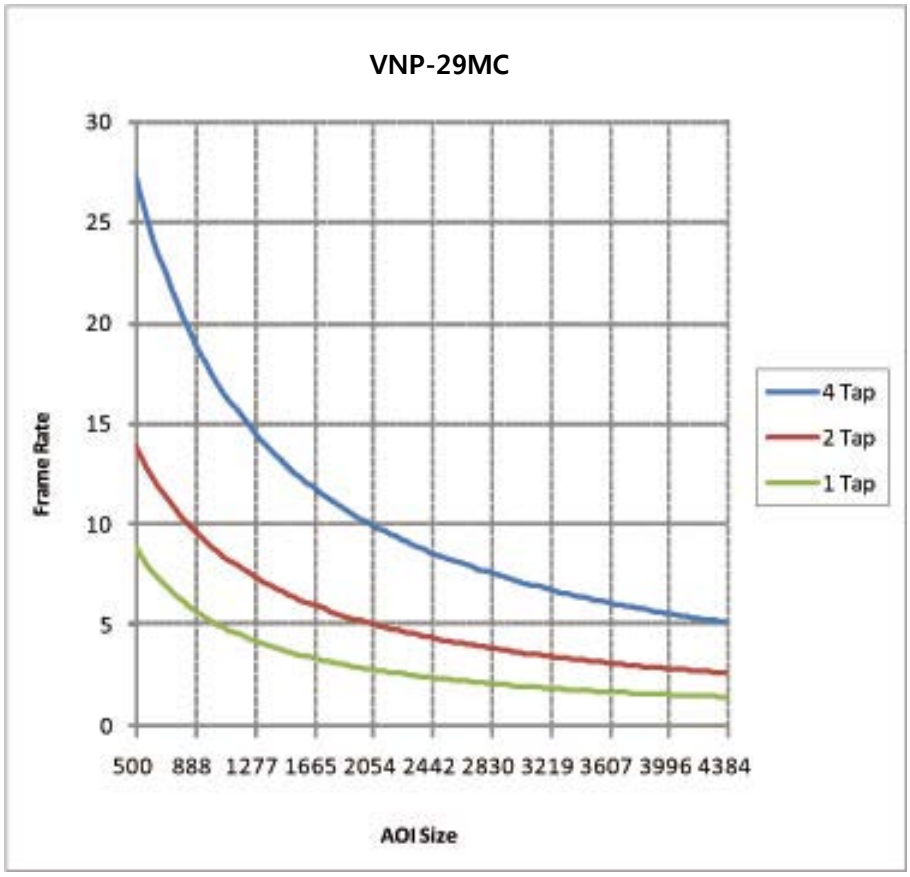


Figure 8.2 Frame Rate by VAOI changes

8.2 Binning

Binning has the effects of increasing the level value and decreasing resolution by adding the values of the adjacent pixels and sending them as one pixel. The camera applies same Binning Factor (2 or 4) to both directions in order to keep the ratio imaging. The below figure shows application of 2 × 2 Binning and 4 × 4 Binning respectively. Since Binning in vertical direction is processed at internal register of CCD, the frame speed increases as many as Binning Factor if Binning is applied, but Binning in horizontal direction does not affect frame speed. Binning Factor is set using “sbf” command.

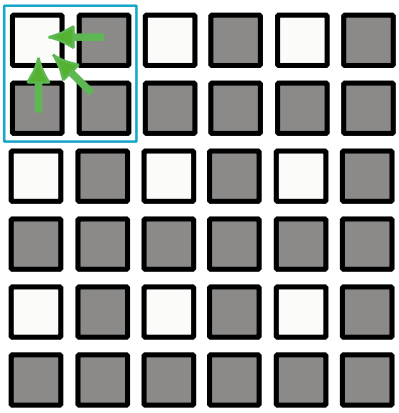


Figure 8.3 2 × 2 Binning

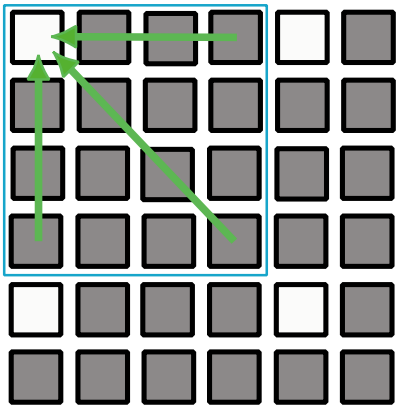


Figure 8.4 4 × 4 Binning

CAUTION	Even if the binning is performed on the color camera, the resulting image will be monochrome.

8.3 Trigger

8.3.1 Trigger Input

Trigger mode of the camera is divided into Trigger synchronous mode and Trigger asynchronous mode (hereinafter “Free-Run mode”) depending on its synchronization with trigger input. Trigger synchronous mode is divided into Standard mode, Double Exposure mode, Fast mode, Overlap mode, depending on concrete operation type.

It is required to set the trigger first to operate the camera in Trigger synchronous mode. In concrete, it is required to select which one of CC1 port and TRIGGER_IN port should be used as trigger input and to set whether polarity of trigger should be Positive or Negative.

8.3.1.1 Free-Run Mode

Free-Run Mode repeats Readout depending on parameter value set in the camera currently, regardless of trigger input.

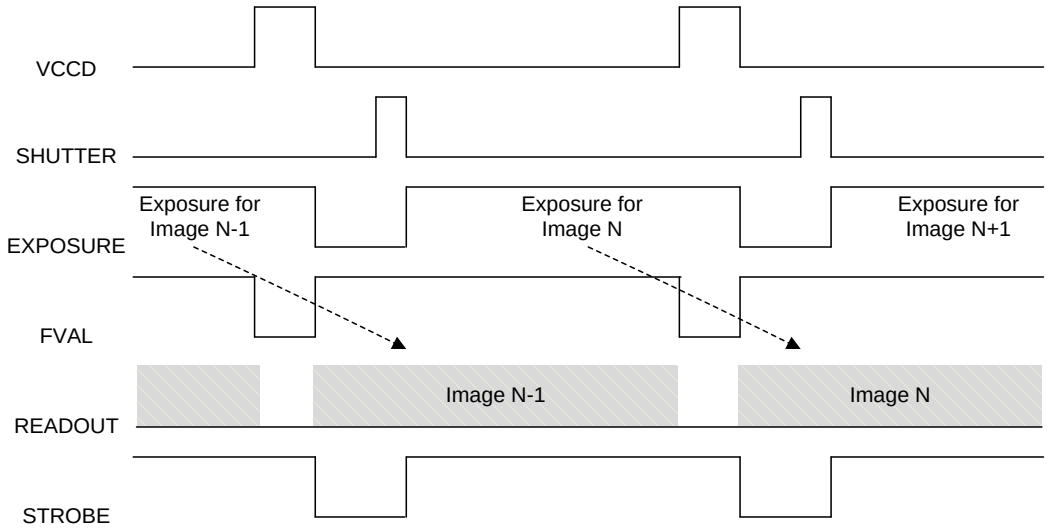


Figure 8.5 Free-Run Mode

As shown in the above figure, Readout section overlaps with exposure section of next image in Free-Run Mode. At this time, the camera operation slightly differs depending on length of Exposure Time and Readout time. If Exposure Time is shorter than Readout, Shutter signal occurs during readout, and when Readout finishes, Readout of next image starts (Figure 7.6). In this case, frame speed is constant regardless of change in Exposure Time. But if Exposure Time is set longer than Readout time, Shutter signal occurs together with start of Readout and Readout of next image does not start until Exposure Time set elapses even if Readout finishes (Figure 7.7). In this case, frame speed gets lower as the setting value of Exposure Time increases.

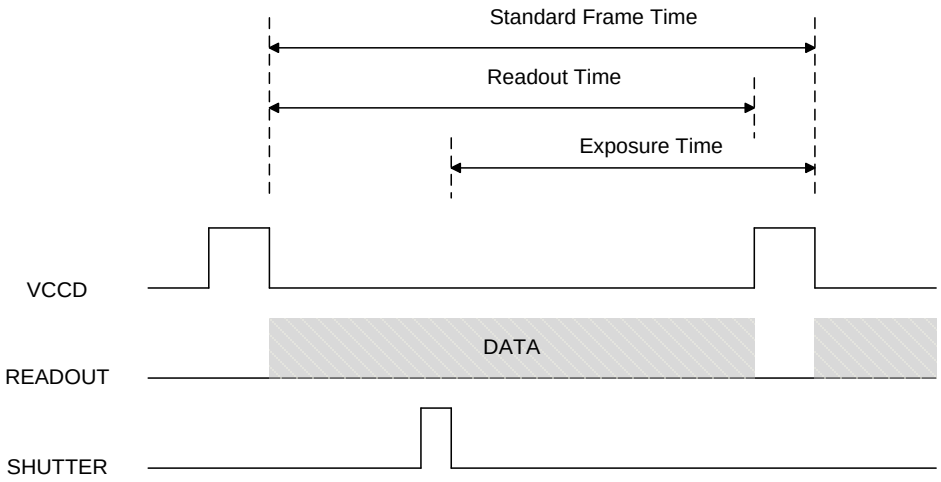


Figure 8.6 Exposure Time is Shorter than Readout Time

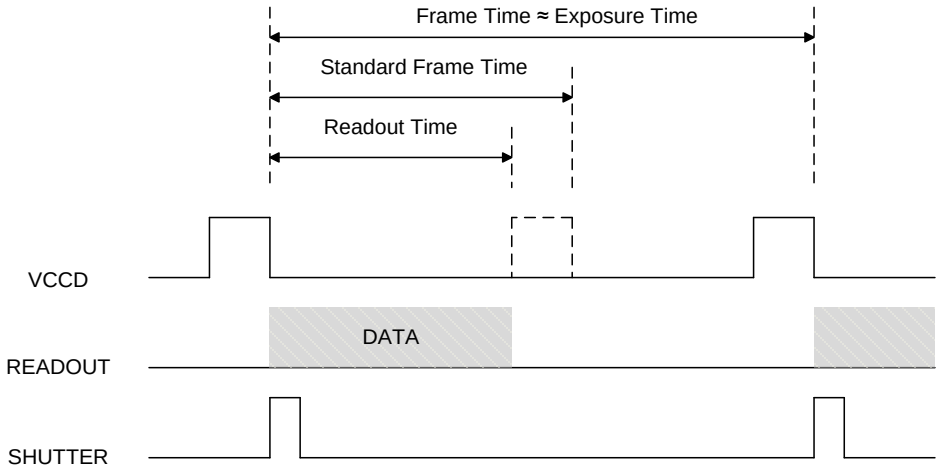


Figure 8.7 Exposure Time is longer than Readout Time

8.3.1.2 Standard Mode

In the Standard Mode, the camera is in a waiting for trigger acquisition status until trigger signal is supplied. When a trigger signal is received by the camera, Readout will start after performing Exposure process according to the setting. After Readout is completed, the camera will return to the waiting for trigger acquisition status again. In Standard Trigger mode, if a new trigger signal is supplied during readout, the new trigger signal will be ignored.

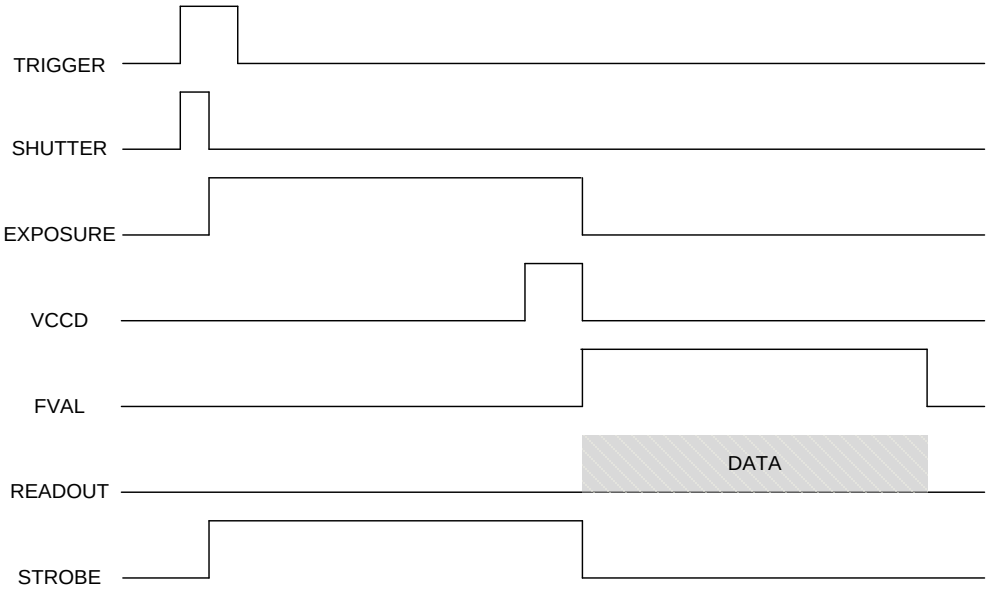


Figure 8.8 Standard Trigger Mode

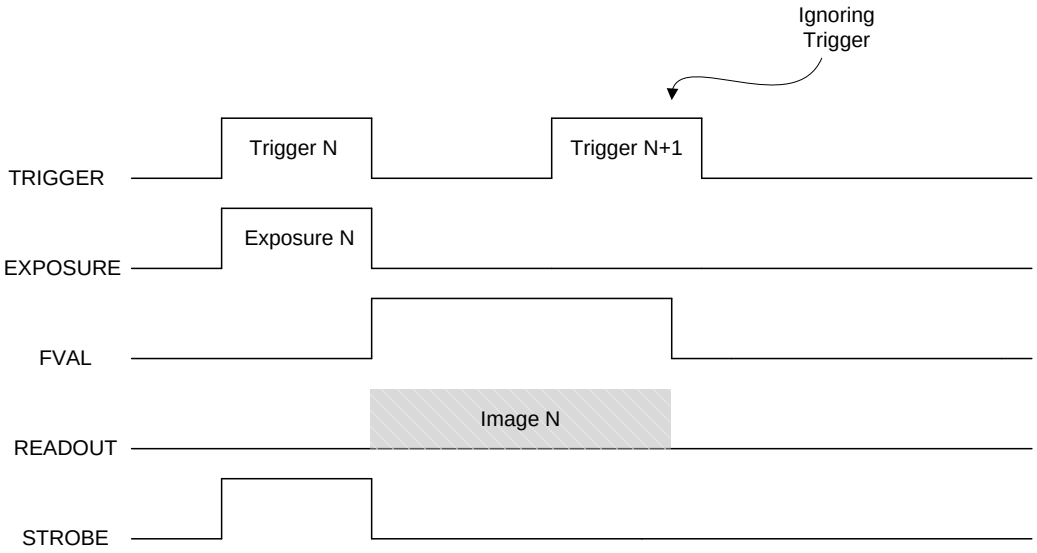


Figure 8.9 Retriggering

8.3.1.3 Double Exposure Mode

In the Double Exposure mode, two images are acquired with one trigger signal. When a trigger signal is supplied in this mode, the camera starts Readout after performing Exposure process according to the setting as in the Standard mode. At this time, exposure for the second image starts with Readout for the first image. When Readout for the first image is completed, the camera performs the second Readout. Since it does not generate shutter signal during Readout for the first image, the interval between completion of first exposure and start of second exposure is as short as a few microseconds or dozens of microseconds.

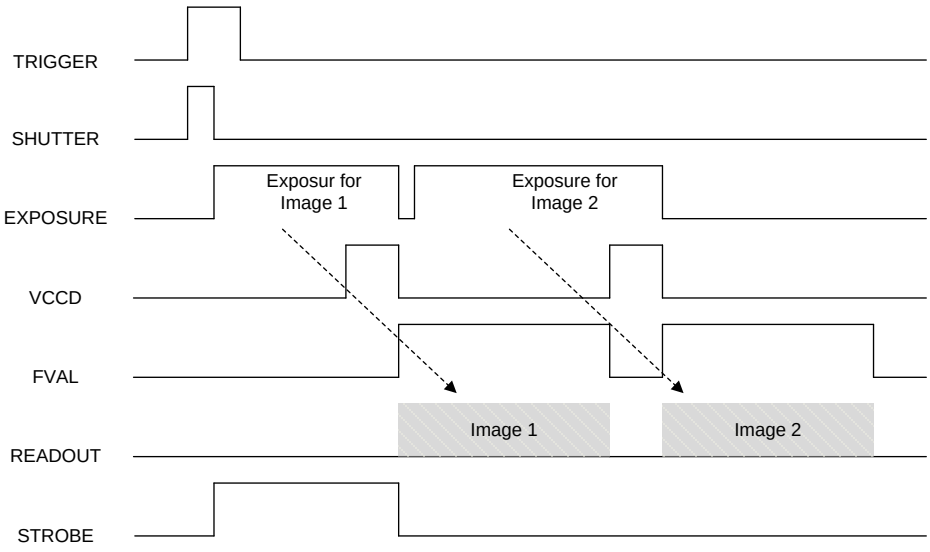


Figure 8.10 Double Exposure Trigger Mode

8.3.1.4 Fast Mode

The Fast mode is more useful than the Standard mode when interval of trigger input is relatively fast and continuous. The difference with the Standard mode is that the Readout immediately starts after a trigger signal is supplied while the Readout starts after performing exposure according to the exposure time setting in the Standard mode. And the interval between trigger signals is equal to the exposure time for the images since it does not generate shutter signal during Readout.

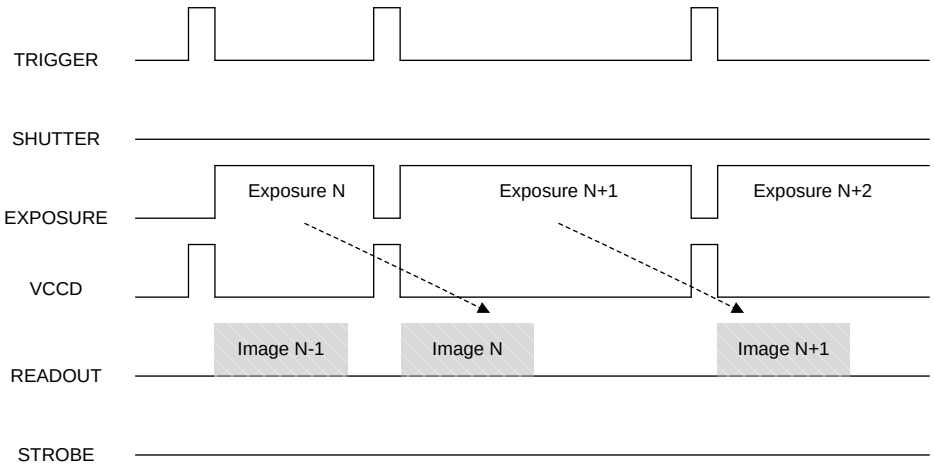


Figure 8.11 Fast Trigger Mode

8.3.1.5 Overlap Mode

In the Overlap mode, the camera remains waiting for trigger acquisition status until a trigger signal is supplied as in the Standard Mode. When a trigger signal is supplied, the Readout starts after performing exposure process according to the exposure time setting. When new trigger signal is supplied to the camera during the Readout process for the first image, the camera will continue to perform the Readout process while performing the exposure process for the new trigger signal. However, if the exposure time is longer than the interval of trigger input and the trigger signal is supplied during the Exposure process, the trigger signal will be ignored. To acquire the image with the maximum frame, the exposure time should not be longer than the readout time and the interval of trigger input should not be shorter than the readout time.

The readout time for VNP-29MC is as follows:

Channel Mode	VNP-29MC
1 channel	763.1 ㎳
2 channel	397.7 ㎳
4 channel	199.6 ㎳

Table 7.2 VNP-29MC Readout Time

In addition, the interval of trigger signal or the exposure time must be kept constant to operate the camera in the Overlap mode ideally.

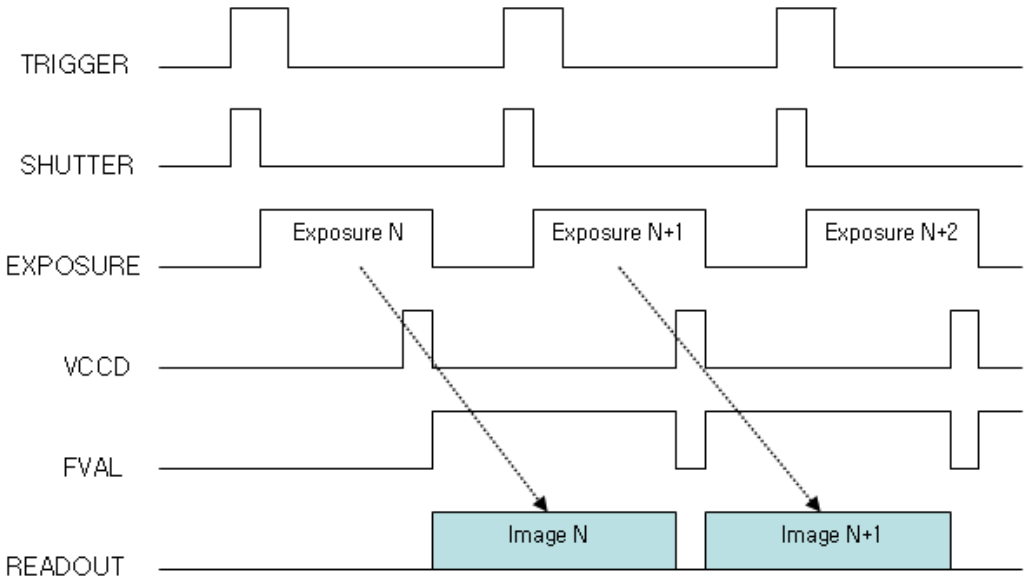


Figure 8.12 Overlap Trigger Mode

8.4 Channel Mode

Accumulated charges are read out of the sensor when exposure ends. The sensor can be read out in one tap (single channel), two tap (dual channel) or four tap (quadrant channel). In case of one tap output, all pixel values in the Horizontal Register are shifted towards the left bottom Video Amplifier (Video A). In case of two tap output, pixel values from left to the center of the Horizontal Register are shifted towards the Video A, and pixel values from the right are shifted towards the Video B. In case of four tap output, pixel values of the lower left area are shifted towards the Video A, pixels values of the lower right area are shifted towards the Video B, pixel values of the upper left area are shifted towards the Video C, and pixel values of the upper right area are shifted towards the Video D. The advantage of four tap output is that it makes readout about 4 times faster than one tap output.

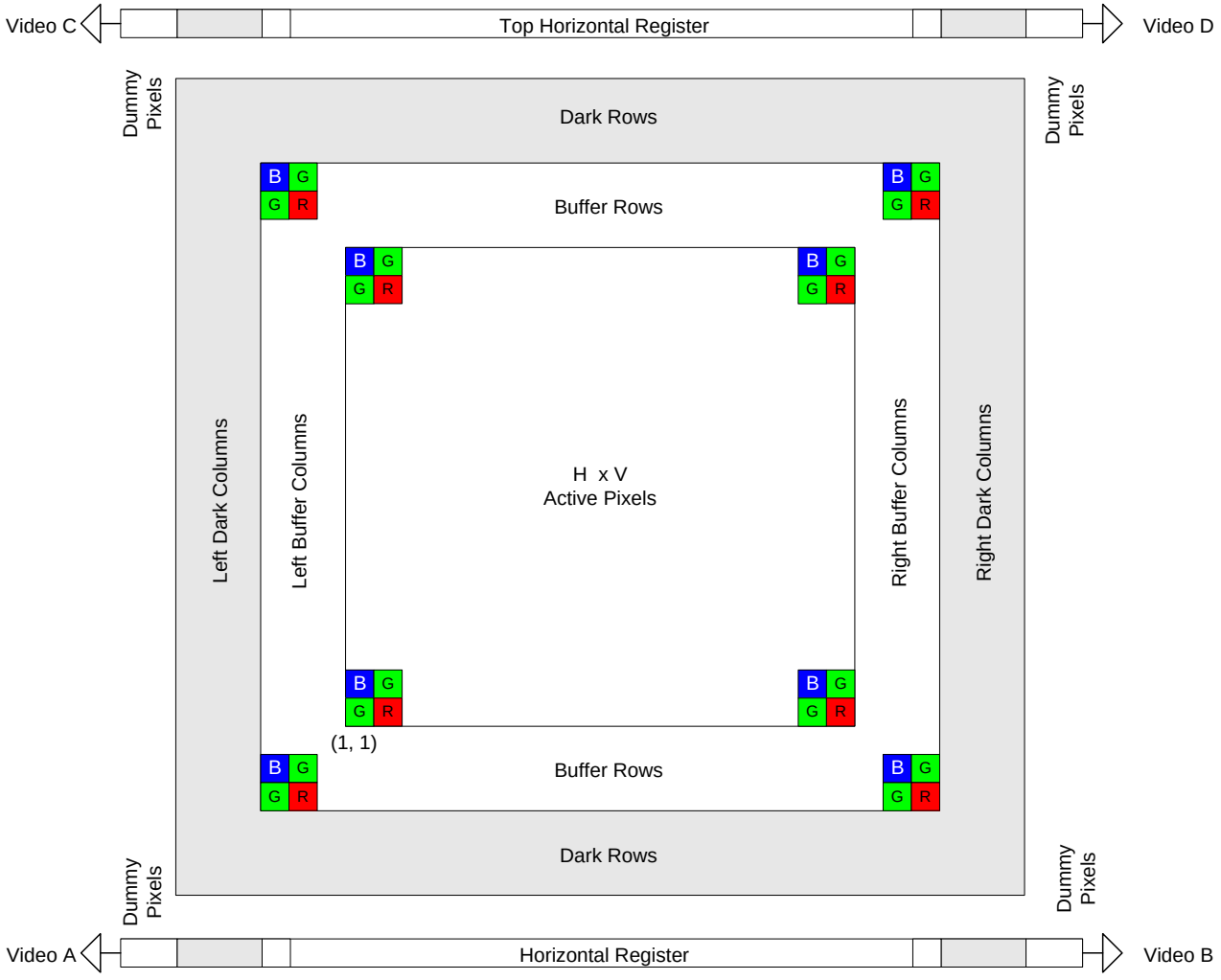


Figure 8.13 Channel Mode

The camera processes and rearranges the image data in order to be compliant with the base Camera Link Standard. In single channel, image data is read out line-by-line from the upper left corner until the last pixel in the lower right corner is read out in the Camera Link A 1 Tap fashion. In dual channel, image data is read out of Channel A and B simultaneously in the Camera Link A, B 2 Tap interleaved fashion. In quadrant channel, image data which is transmitted from Video A, B, C and D simultaneously, is read out of the top half and the bottom half in the Camera Link 2 Tap top and bottom fashion (Figure 7.15).

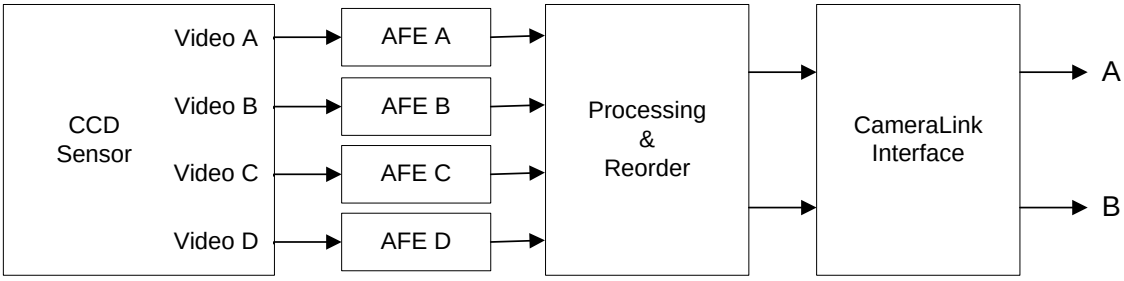


Figure 8.14 Image Data Flow

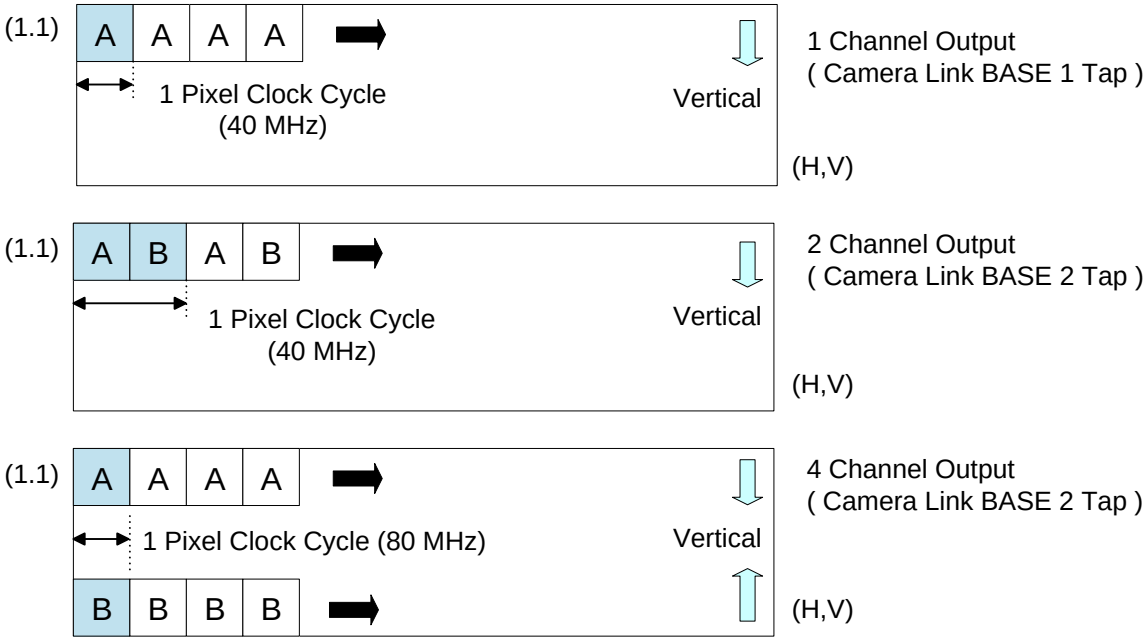


Figure 8.15 Data Output

8.5 Gain and Offset

The camera has one Analog Signal Processor (or Analog Front End, abbreviated to AFE) for each channel. This AFE consists of Correlated Double Sampler (CDS), Variable Gain Amplifier (VGA), Black Level Clamp and 12-bit A/D converter. AFE has register for Gain and Offset application inside, and can change Gain and Offset value by entering proper value in the register. Gain can be set between 0 ~ 899. The relationship between setting value and actual Gain (dB) is as follows:

```
Gain(dB) = (Setting value × 0.035 dB)
```

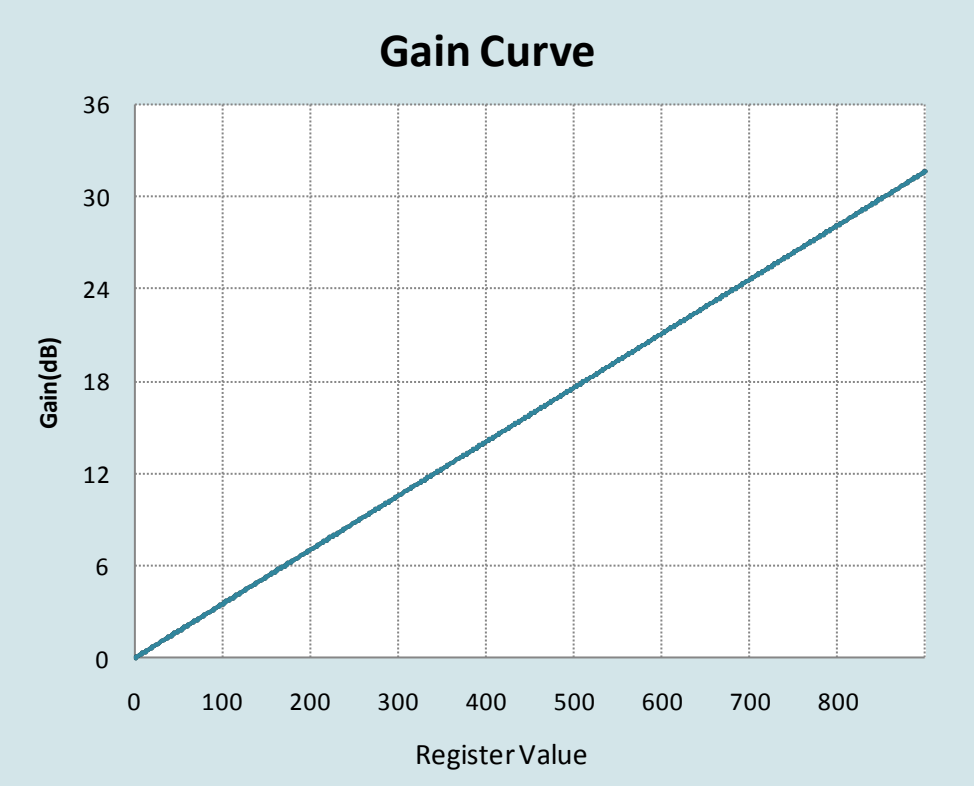


Figure 8.16 Register Setting for Gain Value

The available range of offset values is 0 ~ 255 (LSB).

8.6 LUT

LUT (Lookup Table) converts original image values to certain level values. Since it is mapped one to one for each level value, 12-bit output can be connected to 12-bit input. LUT is in the form of table that has 4096 entries between 0~4095 and provides 2 non-volatile spaces for LUT data storage. You can determine whether to apply LUT and which LUT to use using “sls” command. For more information about how to download LUT to camera, refer to Appendix B.

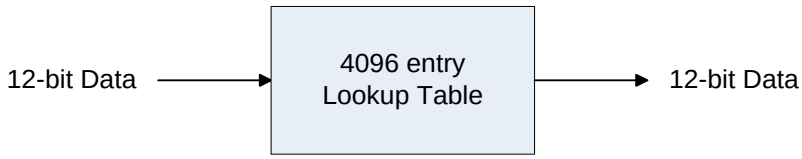


Figure 8.17 LUT Block

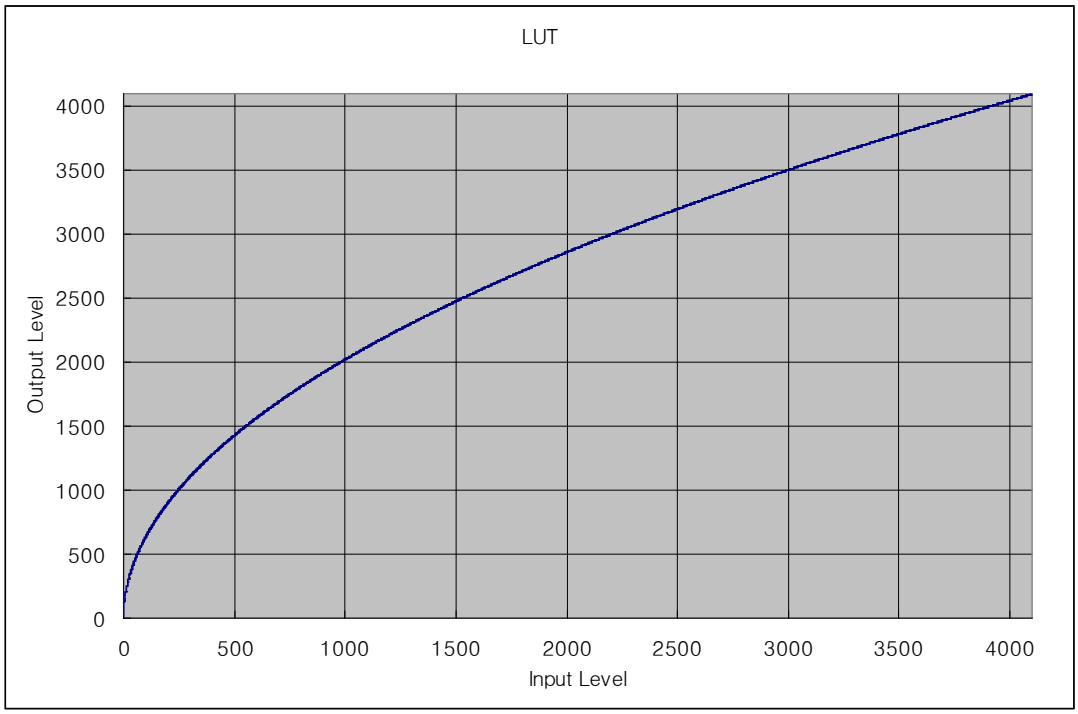


Figure 8.18 LUT at Gamma 0.5

8.7 Defective Pixel Correction

The CCD may have Defect Pixels which cannot properly react to the right. Correction is required since it may deteriorate the quality of output image. Defect Pixel information of CCD used for each camera is entered into the camera during the manufacturing process in the factory. If you want to add Defect Pixel information, it is required to enter coordinate of new Defect Pixel into the camera.

For more information, refer to Appendix A. “sdc” command is used to set whether to use Defective Pixel Correction feature.

8.7.1 Correction Method

Correction value for a defect pixel is calculated based on valid pixel value adjacent in the same line.

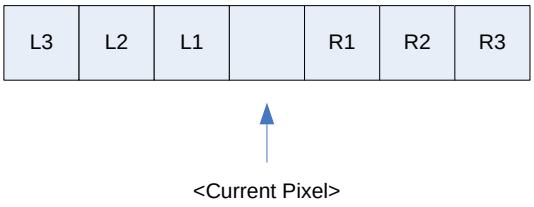


Figure 8.19 Location of Defect Pixel to be corrected

If current pixel is a defect pixel as shown in the above figure, correction value for this pixel is obtained as shown in the following table depending on whether surrounding pixel is defect pixel or not.

Adjacent Defect Pixel(s)	Correction value of Current Pixel
None	(L1 + R1) / 2
L1	R1
R1	L1
L1, R1	(L2 + R2) / 2
L1, R1, R2	L2
L2, L1, R1	R2
L2, L1, R1, R2	(L3 + R3) / 2
L2, L1, R1, R2, R3	L3
L3, L2, L1, R1, R2	R3

Table 7.3 Calculation of Defective Pixel Correction Value

8.8 Flat Field Correction

The Flat Field Correction feature improves the image uniformity when you acquire a non-uniformity image due to external conditions. The Flat Field Correction feature can be summarized by the following equation:

```
IC = {(IR – IB) × M } / (IF – IB)

Where,
IC:  Level value of corrected image;
IR:  Level value of original image;
IB:  Black offset value;
M:   Offset value of image after correction;
IF:  Level value of Flat Field data.
```

In order to use the Flat Field Correction function, one must first generate IF, the Flat Field data. This can be done by adjusting the camera to the actual environment and activating the Flat Field Generator. The Flat Field Generator will standardize a series of images, curtailing the image to 1/16 pixel, generate the curtailed Flat Field data, and store it in the external frame buffer. When curtailed images are used for corrections, it is expanded and applied with a Bilinear Interpolation as shown in Figure 7.21. When the Flat Field data is generated, use the “sfo” command to set the M value, and use the “sfc” command to apply the Flat Field Correction. At this time, the Flat Field data is stored on the RAM, a volatile memory. In order to reuse the stored data, the “sdf” command must be used to store them on the FLASH, a non-volatile memory.

1. Activating the Flat Field Generator will ignore the current camera settings and will temporarily change the camera settings to operate under the following default conditions. When the generation of the Flat Field data is completed, the original settings of the camera will be restored.
   - Readout Mode: Normal
   - Trigger Mode: Free-Run
   - Channel Mode: Single
   - Defective Pixel Correction: ON
2. The offset value M is based on the Normal Readout mode. According to the AOI mode, Binning mode, or Dual Channel mode, the offset value of an actual image is expressed differently.

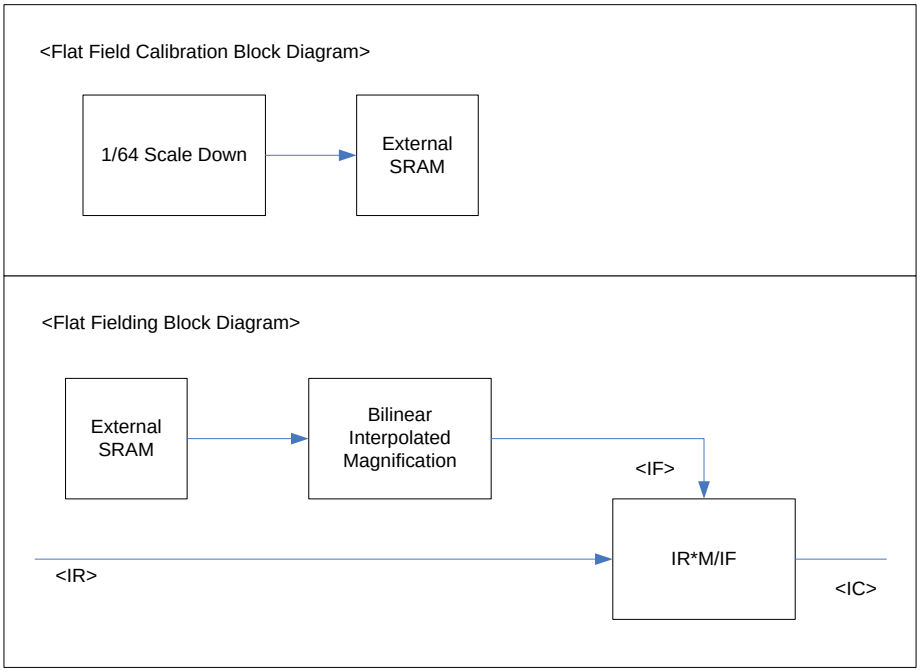


Figure 8.20 Generation and Application of Flat Field Data

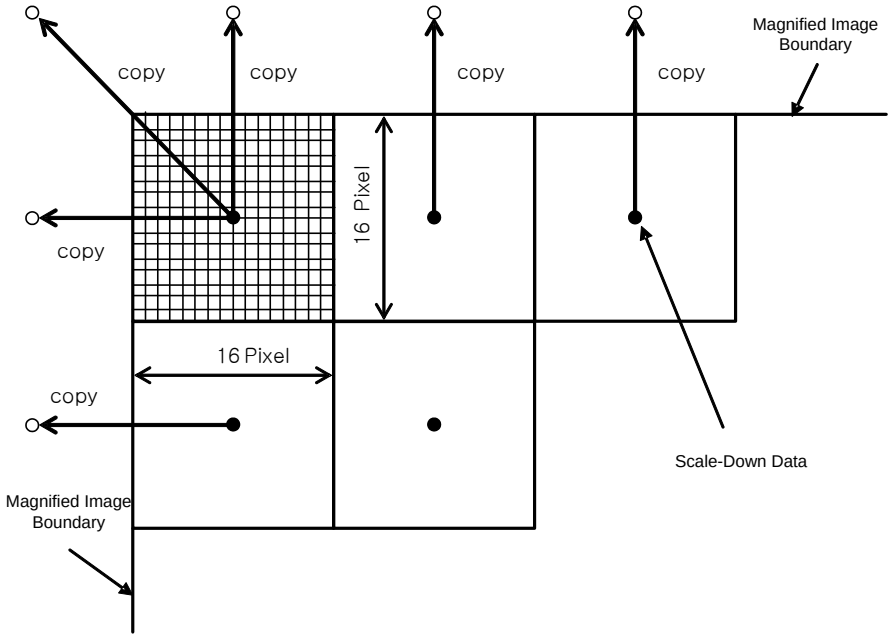


Figure 8.21 Bilinear Interpolated Magnification

8.9 Dark Signal Non-uniformity Correction

In theory, when an area scan camera captures a frame in complete darkness, all of the pixel values in the frame should be near zero and they should be equal. In practice, however, slight variations in the performance of the pixels in the sensor will cause some variations in the pixel values output from the camera when the camera is capturing in darkness. This variation is known as Dark Signal Non-uniformity (DSNU). The VNP-29MC provides the DSNU Correction feature. “sdsnu” command is used to set whether to use the DSNU correction feature.

 CAUTION	When you enable the **DSNU** Correction feature, you cannot acquire frames at the camera’s nominal maximum frame rate. • This is true because the camera takes time (milliseconds) to apply the DSNU Correction feature after reading out the pixel values. • When you acquire frames using the CC1 or external triggering, you must consider the triggering cycle properly.

8.10 Temperature Monitor

A sensor chip is embedded in the camera to monitor the internal temperature. “gct” command is used to check the temperature of camera.

8.11 Status LED

A green LED is installed on the back panel of the camera to inform the operation status of the camera.
LED status and corresponding camera status are as follows:

- Continuous ON operates in the Free-Run mode.
- Repeat ON for 0.5 seconds, OFF for 0.5 seconds: operates in the Trigger mode.
- Repeat ON for 1 second, OFF for 1 second: outputs Test Image.
- Repeat ON for 0.25 second, OFF for 0.25 second: operates in the Trigger mode and outputs Test Image.

8.12 Pixel Shift

The Pixel Shift camera shifts the image sensor to X and Y direction precisely with 1/2 or 1/3 pixel distance using 2D-Stage. The resulting image can be combined of 4 individual images captured by shifting the image sensor to X and Y direction with 1/2 pixel distance as shown in the figure below. Thus, the output image offers improved resolution (4 shot result image) in comparison with standard output image (1 shot result image). Combining the images should be done on the PC side with software processing. Please contact local dealer or factory representative for the details on the sample software combining the images.

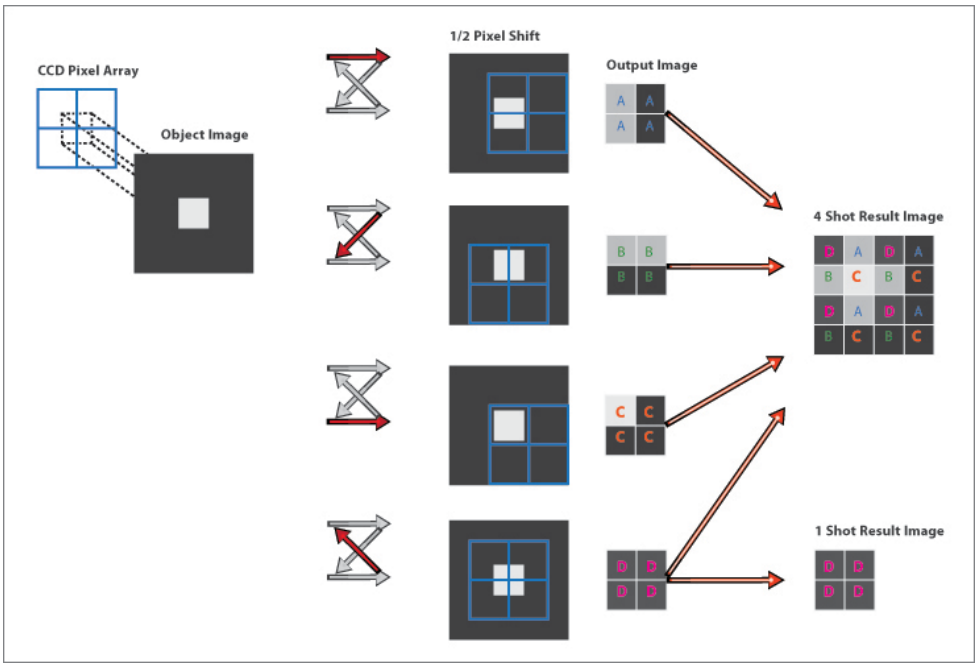


Figure 8.22 1/2 Comparison of resolution between Pixel Shift camera and standard camera

CAUTION	• The camera contains components sensitive to heat, shock, or vibration. Handle this camera with the maximum care. Operate the camera at temperature between 10℃ and 40℃. • Due to a temperature difference between the product and environment, moisture may condense inside or outside the camera. This moisture condensation may cause a malfunction of the camera or shorten the product life cycle. If some condensation occurs, turn off the camera and wait about an hour for the moisture to evaporate.

8.12.1 Pixel Shifting and True Color resolution

One benefit of pixel shifting technology in comparison to fixed sensor cameras is its ability to acquire more than 4 times higher resolution than the fixed one. The below figure shows standard output image and ×9 shifting output image. In case of VNP-29MC camera model, the output image will have 19,728 × 13,152 (259.5 Megapixel) resolution if the pixel shifting is applied. Otherwise, the resolution of output image is 6,576 × 4,384 (28.8 Megapixel) without the pixel shifting.

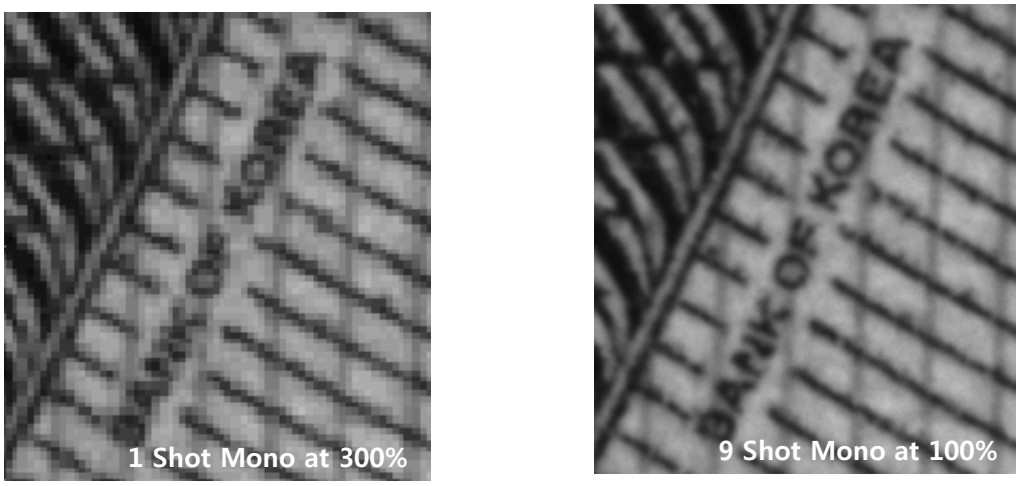


Figure 8.23 Standard (left) vs 9 Shot Pixel Shifting (right)

Another benefit of pixel shifting technology compared to fixed CCDs is acquiring True Color image. Currently CCD cameras use Bayer Interpolation to produce color images so that unwanted artifacts can occur such as color moiré or false color pixels. Using pixel shifting, no color artifacts or aliasing will occur and the color resolution is optimized.

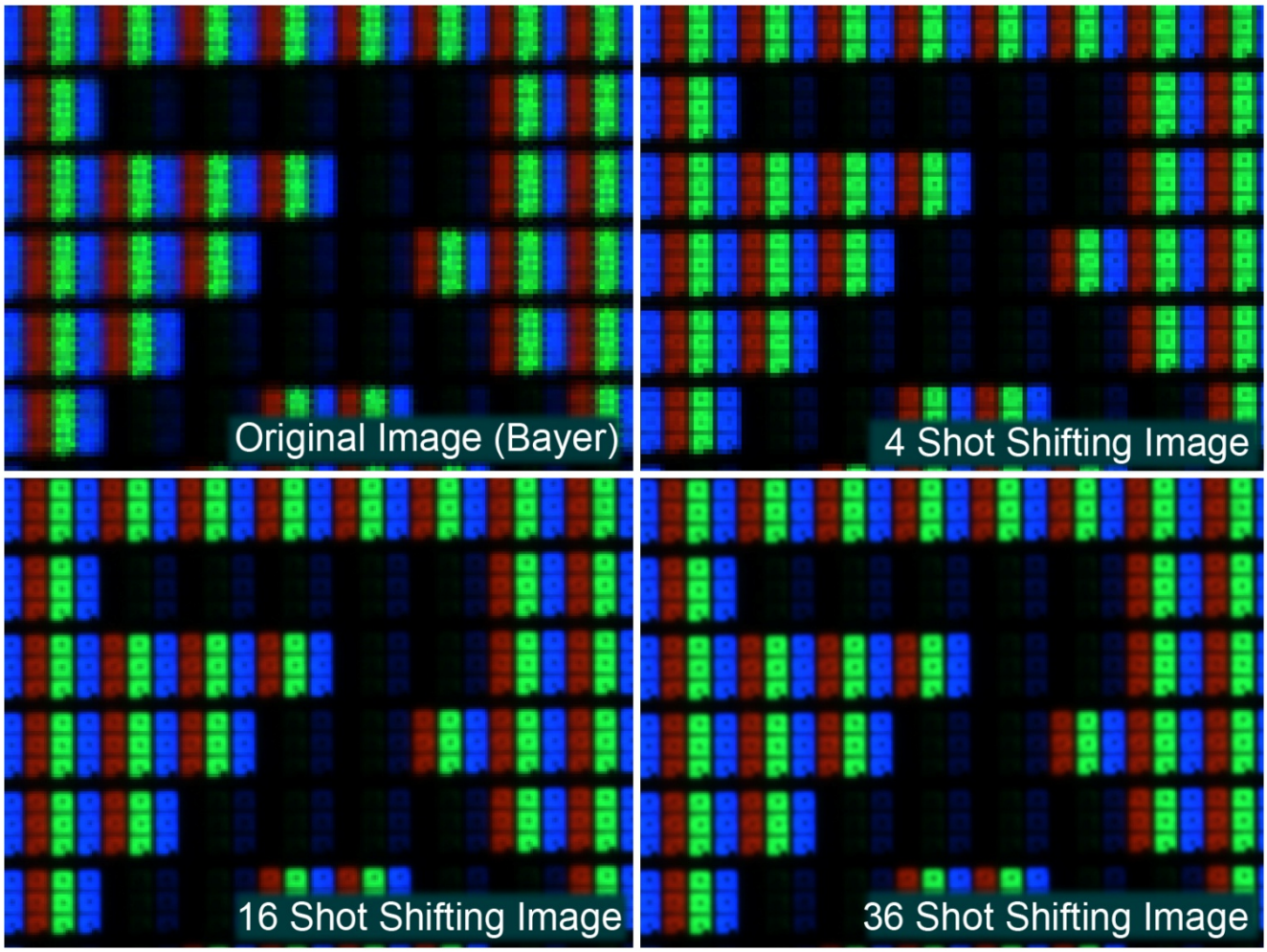


Figure 8.24 Standard Image Color vs Shifting Image Color

CAUTION	Use VNP Series camera where subjects are fixed and lighting environment is constant.

8.12.2 Sequence Mode

8.12.2.1 Components of Sequence Mode

Sequence Mode can be set with the following options.

- 0. None (Manual)
- 1. 4 Shot Mono (Doubled vertical and horizontal resolution)
- 2. 9 Shot Mono (Tripled vertical and horizontal resolution)
- 3. 4 Shot Bayer Color (Full color resolution)
- 4. 16 Shot Bayer Color (Full color resolution, doubled vertical and horizontal resolution)
- 5. 36 Shot Bayer Color (Full color resolution, tripled vertical and horizontal resolution)

8.12.2.2 Operation of Sequence Mode

In 1 – 6 sequence modes where the position of the stage has been predefined, the sequence operates by applying only trigger signal. The default position of the stage is (0, 0) and the following position will vary depending on the sequence mode. Once one cycle of operation has completed, the stage position returns to (0, 0). When the camera is running in the Free-Run mode, the sequence mode will be deactivated because the sequence mode is synchronized only with external Trigger or CC1 Trigger. Refer to Appendix D for the position settings according to sequence modes.

None (Manual) mode is useful when the sequence and stage position need to be configured manually. You can configure the stage position using “snp” serial command.

When you control the stage using serial command manually, it takes about 16 ㎳ from sending the command to shifting the stage. This period includes latency of serial communication and shifting time of the stage. Actually, it takes 8 ㎳ for the stage to be shifted.

To operate correctly in None (Manual) mode, you need to calculate the trigger timing considering frame transfer and stage setup time, and then apply the trigger signal to the camera. The minimum trigger period can be obtained as shown in the following expression:

- When sum of exposure time and stage setup time is shorter than frame transfer time:
  (Frame Transfer Time > Exposure Time + Stage Setup Time)
  - Minimum Trigger Period = Frame Transfer Time
- When sum of exposure time and stage setup time is longer than frame transfer time:
  (Frame Transfer Time < Exposure Time + Stage Setup Time)
  - Minimum Trigger Period = Exposure Time + Stage Setup Time

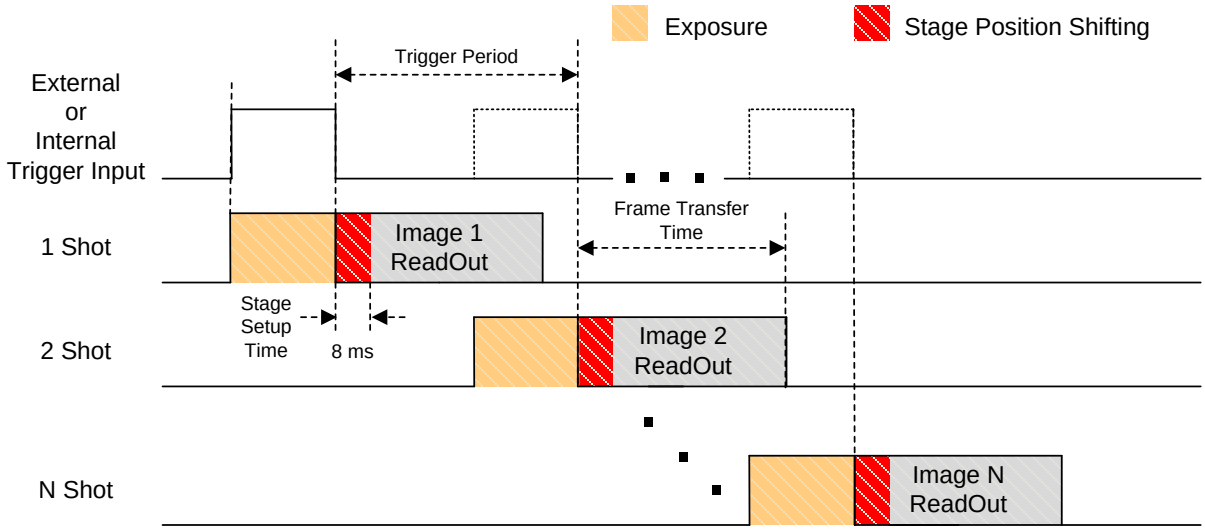


Figure 8.25 Sequence Mode Timing Diagram

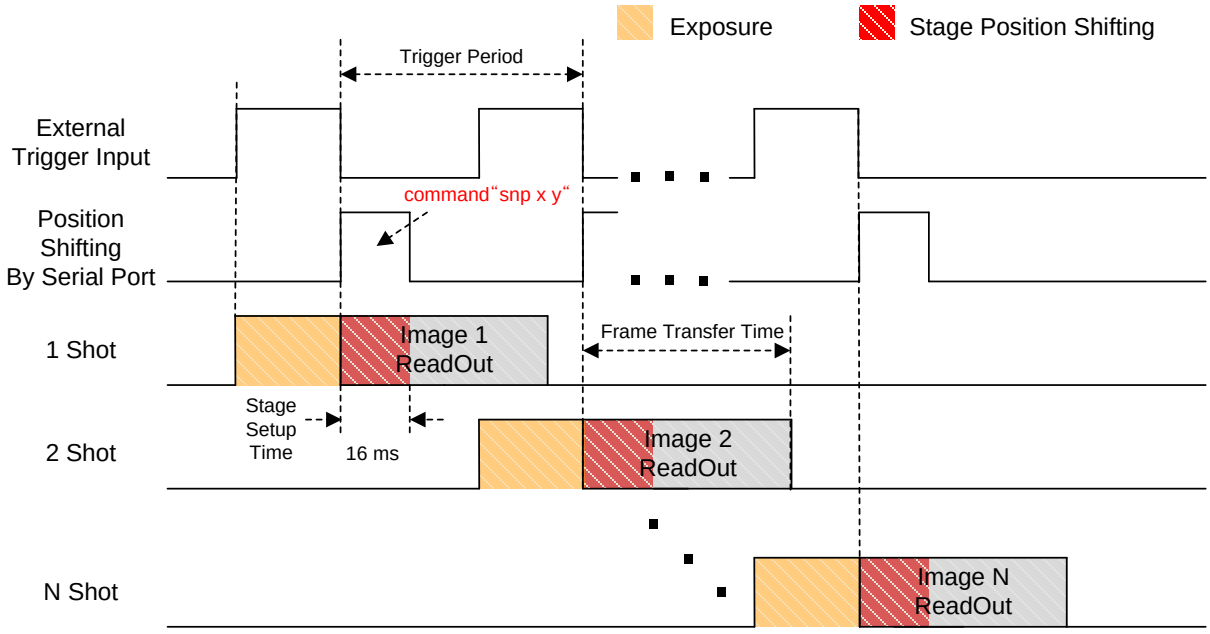


Figure 8.26 Manual Mode Timing Diagram

8.12.2.3 Multi Shot Mode

When Multi Shot Mode is activated, the sequence operation that is followed by the first trigger input will be performed automatically by internal trigger. Internal trigger is generated by calculating the optimized timing reflecting trigger delay and stage setup time. Trigger input from external ports will be ignored until completing the readout of the last image.

```
Multi Shot Enable : 1 trigger N snap
Sequence is performed in sequence with one trigger input.
```

```
Multi Shot Disable : 1 trigger 1 snap
Exposure synchronizes with trigger input and N times trigger input will be
needed to acquire N images.
```

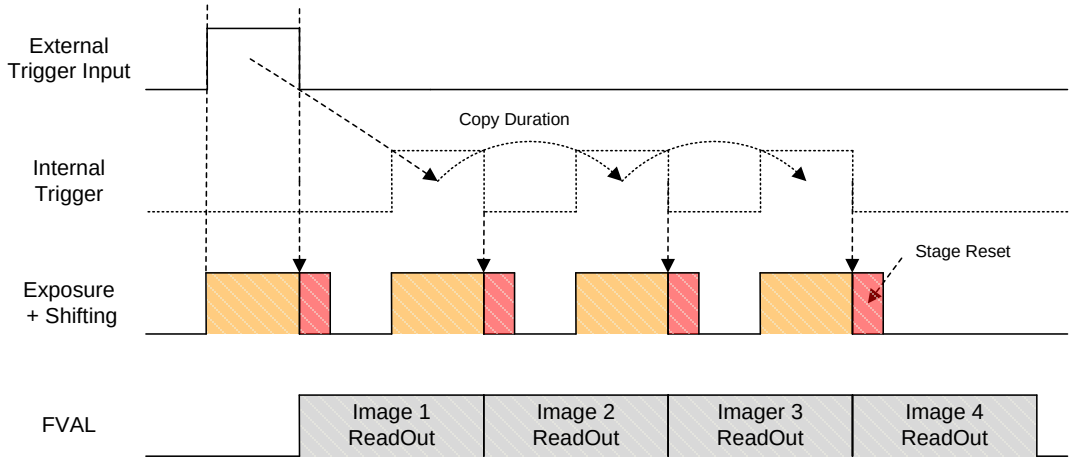


Figure 8.27 Timing Diagram when Multi Shot is enabled on Sequence 4 Shot mode

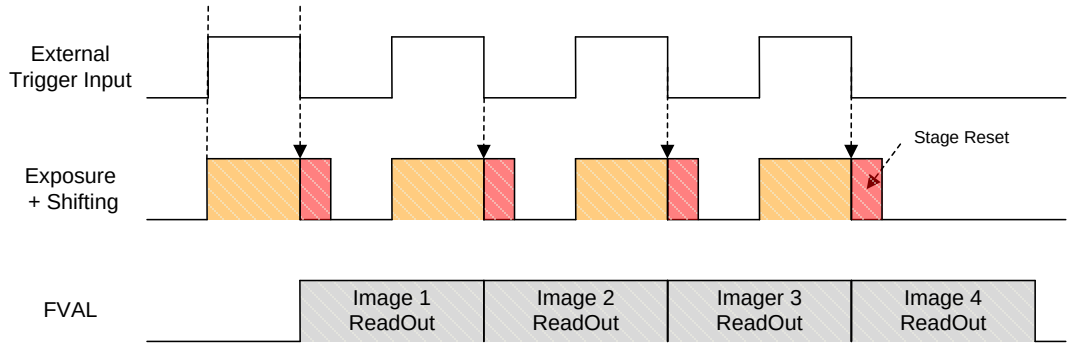


Figure 8.28 Timing Diagram when Multi Shot is disabled on Sequence 4 Shot Mode

8.12.2.4 Stage Reset

The stage can be reset by using Reset command (“rnp”) or Camera Link Camera Control Port (CC2) input.

Stage reset performs following two functions depending on the status of the stage.

- Sequence Mode reset
  - When stage reset command is entered while running the sequence, the camera stops and resets the sequence and then returns to waiting status for trigger input.
- Stage Position Sensor Calibration
  - Zero points can be changed according to temperature changes since the displacement sensor of the stage is sensitive to temperature. This function adjusts zero point of displacement sensor so that the sensor can be maintained within the operating range.

	Zero point drift (the displacement sensor strays from the stage’s operating range) may occur according to a physical change on mechanical parts of the camera or temperature change on installed environment. In this case, executing a Stage Reset command will compensate zero point drift to operate the stage normally.

8.12.2.5 Sequence Auto-Reset

This function will be available only when Sequence mode is activated. Sequence Auto-Reset performs Stage Reset (zero point adjustment) whenever one cycle of sequence is completed.

8.12.2.6 Stage Check

The return values of reset command (“rnp”) or move stage command (“snp”) indicate whether a stage normally operates or not. If a stage normally operates, it returns “OK”, “Error” otherwise. If Multishot is enabled, it is possible to check the stage status without using “rnp” command.

When the stage does not normally operate, the camera stops the current sequence and then checks its status via the number of frame. For example, if you set Sequence Mode to 4 shot, the camera acquires and transfers 4 images normally. However, the camera could unexpectedly stop the sequence so that 4 images cannot be transferred in abnormal operation status. At this time, you can verify the number of frame to check the stage status. You can perform more detailed test on the stage by clicking the **Stage Check** button on the **Stage** tab of Configurator. Then you can send test results to local dealer or manufacturer to diagnose the camera stage.

	An impact of 10G or more would distort the operation range of stage or alignment of the sensor and cause permanent damage to the stage since it is mechanically sensitive to shocks. Please handle the camera with care.

8.12.2.7 Image Arrangement

To acquire the resulting image, you need to combine shifted images into one result image on the PC side with software processing. Sample source or demo program that is helpful to combine images can be provided from the local dealer or manufacturer.

8.13 Data Format

The internal processing of image data is performed in 12 bits. Then, the camera can output the data in 8, 10 or 12 bits. When the camera outputs the image data in 8 bits or 10 bits, the 4 or 2 least significant bits will be truncated accordingly.

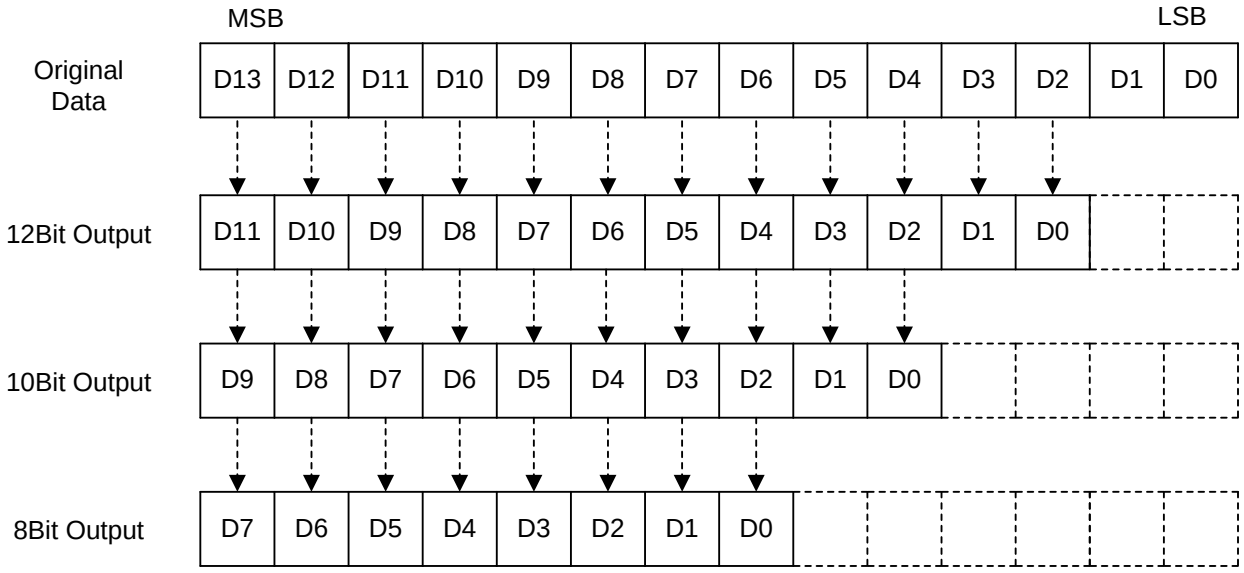


Figure 8.29 Data Format

8.14 Test Image

To check whether the camera operates normally or not, it can be set to output test image generated in the camera, instead of image data from the CCD. Three types of test images are available; image with different value in horizontal direction (Test Image 1), image with different value in diagonal direction (Test Image 2), and moving image with different value in diagonal direction (Test Image 3). Test image can be applied in all operation modes of the camera and is set using “sti” command.

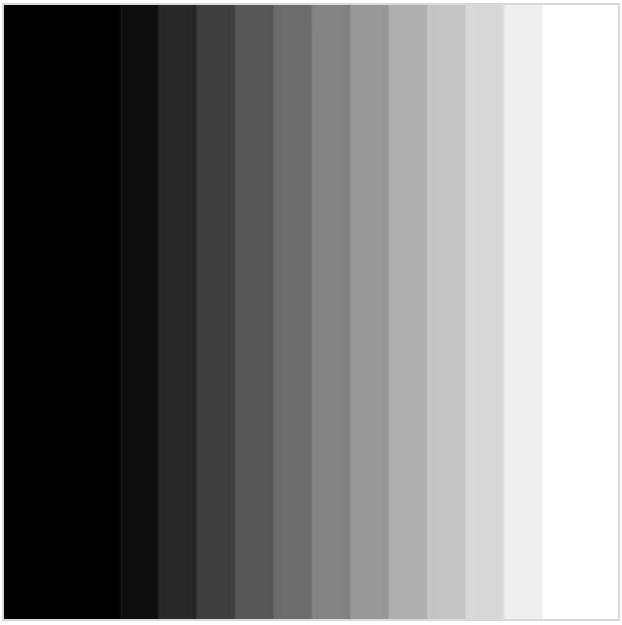


Figure 8.30 Test Image 1

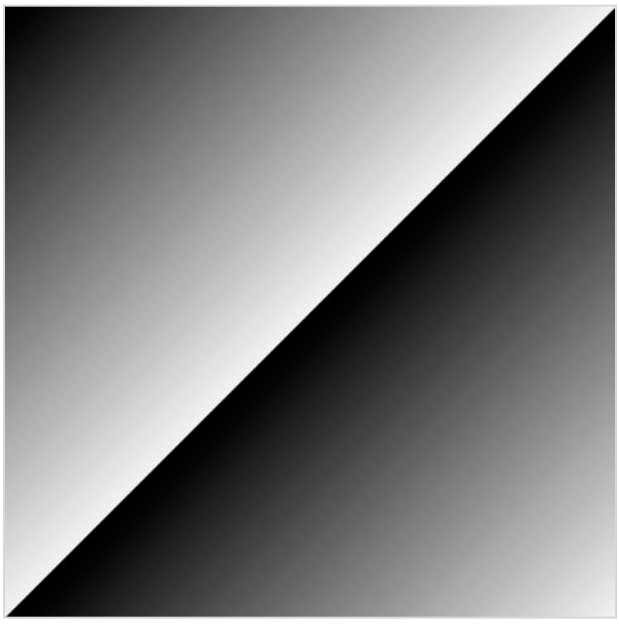


Figure 8.31 Test Image 2

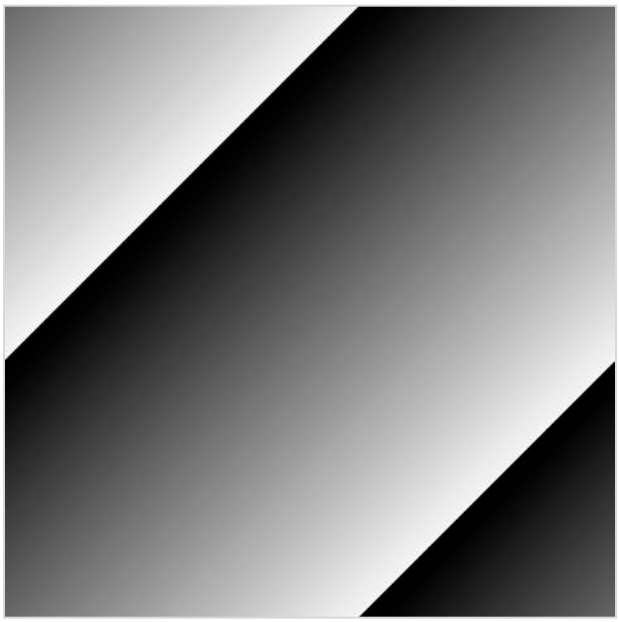


Figure 8.32 Test Image 3

CAUTION	The test image may look different because the region of the test image may vary depending on the camera's resolution.

8.15 Horizontal Flip

The Horizontal Flip feature lets you flip the image horizontally. This feature is available in all operation modes and “shf” command is used to set whether to use this feature or not.

Figure 8.33 Original Image

Figure 8.34 Horizontally Flipped Image

8.16 Image Invert

The Image Invert feature lets you invert the level values of the output image. The inverted level values differ depending on the output data format even if input value is same. This feature is available in all operation modes and “sii” command is used to set whether to use this feature or not.

Data Format	Original Value	Inverted Level Value
8	0	255
10	0	1023
12	0	4095

Table 7.4 Inverted level value by Data Format

Figure 8.35 Original image (Positive)

Figure 8.36 Inverted image (Negative)

8.17 Strobe

The strobe signal is used to synchronize the external light source with the camera or to measure the exposure time of the camera. The pulse width of the strobe signal is determined by the duration from the point where the shutter signal is generated until the point where the readout process begins. It is equivalent to the exposure time of the camera.

8.17.1 Strobe Offset

The strobe offset value indicates when the strobe signal is to be sent after the shutter signal is generated. The value can be set in the unit of 1 μs using “sso” command. Then, the location of the pulse will be changed accordingly without changes in pulse width of the strobe signal.

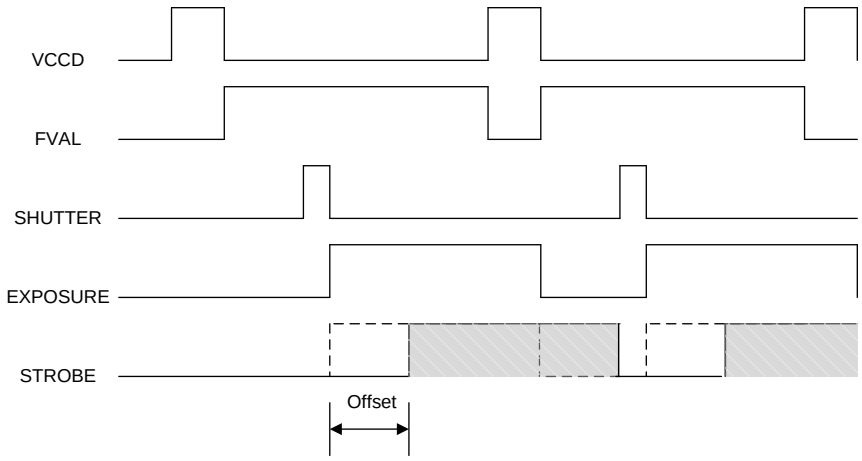


Figure 8.37 Strobe signal in Free-Run

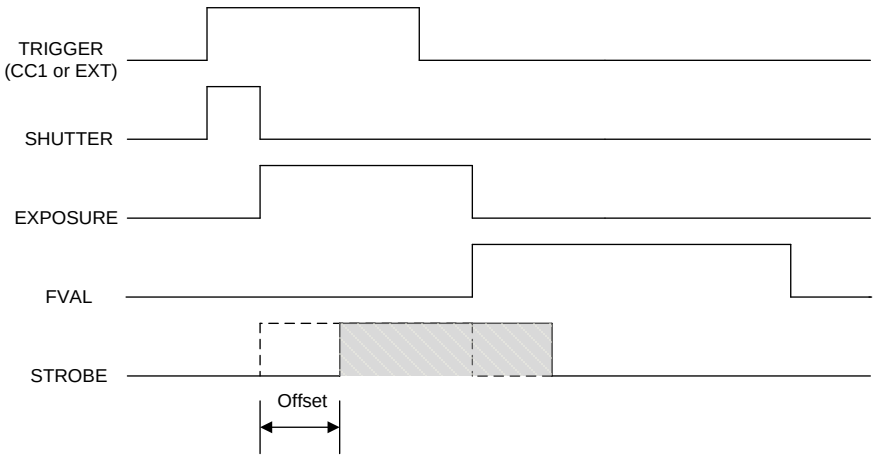


Figure 8.38 Strobe signal in Trigger mode

8.17.2 Strobe Polarity

You can select the polarity of the strobe signal. “ssp” command is used to set the polarity of the strobe signal.

8.18 Field Upgrade

The camera provides a feature to upgrade the firmware and FGPA logic through the camera link interface rather than disassemble the camera in the field. For more information about how to upgrade, refer to Appendix C.

9 Camera Configuration

9.1 Setup command

You can configure all required settings of the camera through RS-644 serial interface of the camera link. When you want to control the camera using a terminal or access to the camera at your application, you need to set your network as follows.

- Baud Rate: 115200 bps
- Data Bit: 8 bit
- Parity Bit: No Parity
- Stop bit: 1 stop bit
- Flow control: None

All types of the camera setting commands are delivered in ASCII command type except Firmware Download requiring massive data transmission. All camera setting commands start from user application and the camera returns the response (“OK”, “Error” or information) for a command. The camera informs the completion of the command execution through response for a write command while the camera returns the error response or information for a read command.

```
Command format:
<command> <parameter1> <parameter2> <\r>
0~2 parameters follow the command.
Response:
- If execution of write command is successfully completed
 OK <\r> <\n>
```

ex) Write command

```
In response to a “set 100” command the camera will return (in hex value)
Command    : 73 65 74 20 31 30 30 0D
             set 100<\r>
Response   : 73 65 74 20 31 30 30 0D 0A 4F 4B 0D 0A 3E
             set 100<\r><\n>            OK<\r><\n>   >
             Echo                       result       prompt
```

```
If execution of read command is successfully completed
<parameter1> <\r> <\n>
```

ex) Read command

```
In response to a “get” command the camera will return (in hex value)
Command     : 67 65 74 0D
              get <\r>
Response    : 67 65 74 0D 0A 31 30 30 0D 0A 3E
              get<\r><\n>    100<\r><\n>    >
              echo           response       prompt
```

```
If execution of command is not completed
Error : <Error Code> <\r> <\n>
```

```
Prompt:
After sending response, Camera sends prompt always. ‘>’is used as prompt.
Types of Error Code
0x80000481 : values of parameter not valid
0x80000482 : number of parameter is not matched
0x80000484 : command that does not exist
0x80000486 : no execution right
```

9.2 Actual Time Applied for Commands

When you execute a command, the actual or real time applied for the command varies depending on the type of the command and operating status of the camera.

All commands except Set Exposure Time ('set') command are applied to change the settings as illustrated below, on the rising edge of a VCCD signal before starting readout process.

When you execute a 'set' command, the exposure time setting will be changed at the starting of the exposure.

In the Trigger mode, you must execute commands before applying trigger signals in order to synchronize image outputs with the commands.

In the Free-Run mode, even if you execute a command, you may acquire up to two images without applying the command. This is true because it is hard to verify the current operating status of the camera in the Free-Run mode.

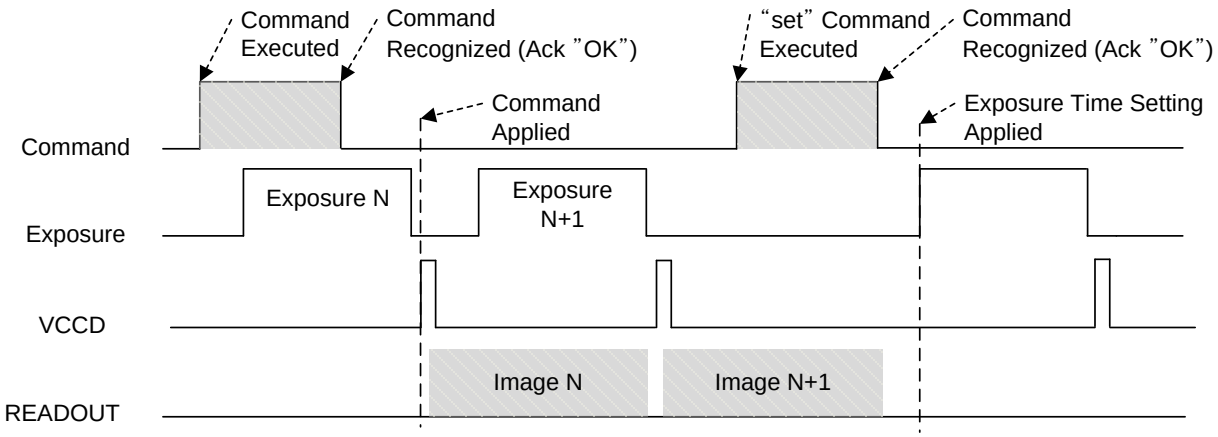


Figure 9.1 Actual Time Applied for Commands

9.3 Parameter Storage Space

The camera has three non-volatile storage spaces used for parameter storage and one volatile work space that is applied to actual camera operation. Three storage spaces are divided into Factory Space that contain basic value at the factory, and two user spaces (User Space 1, User Space 2) that can save parameter value temporarily set by the user. User space can be read and written, but Factory space can be read only.
When the camera is powered on or reset, setting values stored in one of the storage spaces are loaded into the work space according the Config Initialization setting and these values will be used for the camera settings. Since values in the work space are valid only while the power is on, they should be copied to user space 1 or user space 2 using “sct” command.

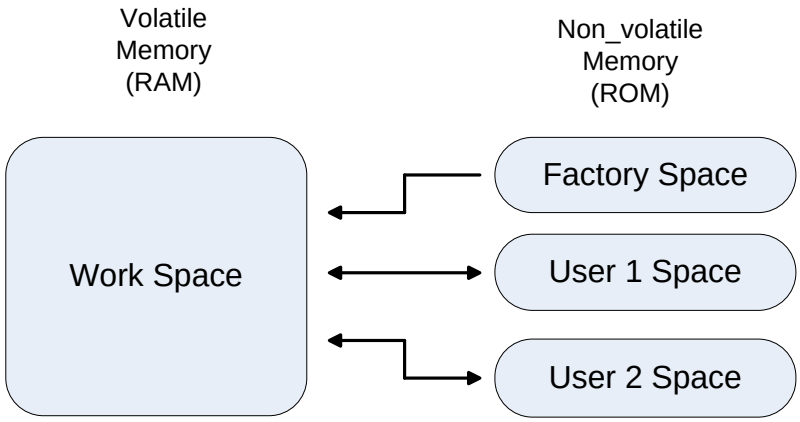


Figure 9.2 Parameter Storage Area

9.4 Command List

Command	Syntax	Value Returned	Description
Help	h	String	Displays a list of all commands
Set Read-Out Mode Get Read-Out Mode	srm 0|1|2 grm	OK 0|1|2	0 : Normal Mode 1 : AOI(Area Of Interest) Mode (AOI area is set using “sha” and “sva” commands) 2 : Binning(2 or 4) Mode (Binning Factor is set using “sbf” command)
Set Horizontal Area Get Horizontal Area	sha n1 n2 gha	OK n1 n2	n1: Starting point of horizontal direction n2 : End point of horizontal direction
Set Vertical Area Get Vertical Area	sva n1 n2 gva	OK n1 n2	n1 : Starting point of vertical direction n2 : End point of vertical direction
Set Binning Factor Get Binning Factor	sbf 2|4 gbf	OK 2|4	2 : 2 by 2 binning 4 : 4 by 4 binning
Set Test Image Get Test Image	sti 0|1|2|3 gti	OK 0|1|2|3	0 : Off 1/2 : Fixed Pattern Image 3 : Moving Pattern Image
Set Data Bit Get Data Bit	sdb 8|10|12 gdb	OK 8|10|12	8 : 8 Bit Output 10 : 10 Bit Output 12 : 12 Bit Output
Set LUT Select Get LUT Select	sls 0|1|2 gls	OK 0|1|2	0 : Off 1 : LUT1 2 : LUT2
Set Asynchronous Reset Get Asynchronous Reset	sar 0|1 gar	OK 0|1	0 : Inactivate Asynchronous Reset 1 : Activate Asynchronous Reset
Set Channel Mode Get Channel Mode	scm 1|2|4 gcm	OK 1|2|4	1 : 1 Channel Mode 2 : 2 Channel Mode 4 : 4 Channel Mode
Set Flat-Field Correction Get Flat-Field Correction	sfc 0|1 gfc	OK 0|1	0 : Off 1 : Active of Flat-Field Correction
Set Defect Correction Get Defect Correction	sdc 0|1 gdc	OK 0|1	0 : Off 1 : Active of Defect Correction

Table 9.1 Command List #1

Command	Syntax	Value Returned	Description
Set Image Invert Get Image Invert	sii 0|1 gii	OK 0|1	0 : Off 1 : Active of Image Invert
Set Trigger Mode Get Trigger Mode	stm 0|1|2|3|4 gtm	OK 0|1|2|3|4	0 : Free-Run Mode 1 : Standard Mode 2 : Fast Mode 3 : Double Mode 4 : Overlap Mode
Set Exposure Source Get Exposure Source	ses 0|1 ges	OK 1|2	0 : Program Exposure(by camera) 1 : Pulse Width (by trigger input signal)
Set Trigger Source Get Trigger Source	sts 1|2 gts	OK 1|2	1 : CC1 Port Input (Camera Link) 2 : External Input (External control port)
Set Trigger Polarity Get Trigger Polarity	stp 0|1 gtp	OK 0|1	0 : Active Low 1 : Active High
Set Exposure Time Get Exposure Time	set n get	OK n	n : Exposure Time in us (Setting range : 10 ~ 7,000,000 ㎲)
Set Strobe Offset Get Strobe Offset	sso n gso	OK n	n : Strobe Offset Time in us (Setting range : 0 ~ 10,000 ㎲)
Set Strobe Polarity Get Strobe Polarity	ssp 0|1 gsp	OK 0|1	0 : Active Low 1 : Active High
Set Analog Gain Get Analog Gain	sag n gag	OK n	n :Analog Gain Parameter (Setting Range : 0 ~ 899)
Set Analog Offset Get Analog Offset	sao n gao	OK N	n :Analog Gain Parameter (Setting Range : 0 ~ 255)
Set Gain Offset Get Gain Offset	sgo 2|3|4 n ggo 2|3|4	OK n	2 : AFE Channel of Right Top Image 3 : AFE Channel of Left Bottom Image 4 : AFE Channel of Right Bottom Image n : Analog Gain offset Parameter (Setting Range : -20 ~ +20)
Auto Gain Offset	ago	OK	Auto-Generation Gain Offset

Table 9.2 Command List #2

Command	Syntax	Value Returned	Description
Generate Flat Field Data	gfd	OK	Operate Flat Field Generator
Save Flat Field Data	sfd	OK	Save Flat Field Data
Load Flat Field Data	lfd	OK	Load Flat Field Data
Set Flat Field Iteration Get Flat Field Iteration	sfi n gfi	OK n	n : (2 ^ n) image acquisitions (Setting Range : 0 ~ 4)
Set Flat Field Offset Get Flat Field Offset	sfo n gfo	OK n	n : Flat Field Target Level (Setting Range : 0 ~ 4095)
Set Dark Signal Non-uniformity Get Dark Signal Non-uniformity	sdsnu 0|1 gdsnu	OK 0|1	0: Disable DSNU 1: Enable DSNU

Table 9.3 Command List #3

Command	Syntax	Value Returned	Description
Load Config From	lcf 0|1|2	OK	0 : Load from Factory Setting 1 : Load from User 1 Setting 2 : Load from User 2 Setting
Save Config To	sct 1|2	OK	0 : Save to User 0 Setting (inactive) 1 : Save to User 1 Setting 2 : Save to User 2 Setting
Set Config Initialization Get Config Initialization	sci 0|1|2 gci	OK 0|1|2	0 : Load from Factory Setting when initializing 1 : Load from User 1 Setting when initializing 2 : Load from User 2 Setting when initializing
Get MCU Version	gmv	String	Displays MCU Version
Get Model Number	gmn	String	Displays Camera Model Number
Get FPGA Version	gfv	String	Displays FPGA Version
Get Serial Number	Gsn piece	String	Display Serial Number
Get Current Temperature	gct	String	Display Temperature Value

Table 9.4 Command List #4

Command	Syntax	Value Returned	Description
Set Nano-Stage Position Get Nano-Stage Position	Snp <axis> <pos> Gnp <axis>	OK <pos>	Move stage to specified position Axis : x or y Pos : position Ex) snp x 50 : move stage to 50 ㎚ position toward x coordinate.
Reset Nano-Stage Position	rnp		Reset stage position to (0,0) & Calibrate stage position sensor.
Set Sequence Mode Get Sequence Mode	Ssm 0|1|2|3|4|5 Gsm	OK 0|1|2|3|4|5	0 : None(Manual) 1 : 4 Shot Mono 2 : 9 Shot Mono 3 : 4 Shot Color 4 : 16 Shot Color 5 : 36 Shot Color
Set Multi Shot Enable Get Multi Shot Enable	Sme 0|1 Gsm	OK 0|1	0 : Disable 1 : Enable
Set Reset Polarity Get Reset Polarity	Srp 0|1 Grp	OK 0|1	Set Camera Link – CC2 Port (Stage Reset) Polarity 0 : Active Low 1 : Active High
Set Sequence Auto-Reset Get Sequence Auto-Reset	Ssr 0|1 Gsr	OK 0|1	Stage reset after stage sequence 0 : Off 1 : On
Set Fan Control Get Fan Status	Sft 0|1 gft	OK 0|1	Control Fan On/Off 0 : Fan Off 1 : Fan On
Set Peltier Control Get Peltier Status	stc 0|1 gft	OK 0|1	Control Peltier On/Off 0 : Peltier Off 1 : Peltier On

Table 9.5 Command List #5

10 Configurator GUI

Configurator, a sample application, is provided to control VNP Series camera. Configurator provides easy-to-use Graphic User Interface (GUI) for the user while using the commands mentioned in the previous chapters.

10.1 Camera Scan

When you execute the program while the camera is turned on, a Camera Scan window appears as shown in the figure below. At this time, the program checks serial port of your computer and DLL provided by the camera link to scan whether the camera is connected. If there is a camera connected, it displays model name on the screen. If the camera is not properly displayed on the screen, check the connection of cables and power of the camera, and press the **refresh** button. When you double-click a model name displayed on the screen, Configurator is executed and displays current setting value of the camera connected.

Figure 10.1 Configurator Loading Window

10.2 Menu

10.2.1 File

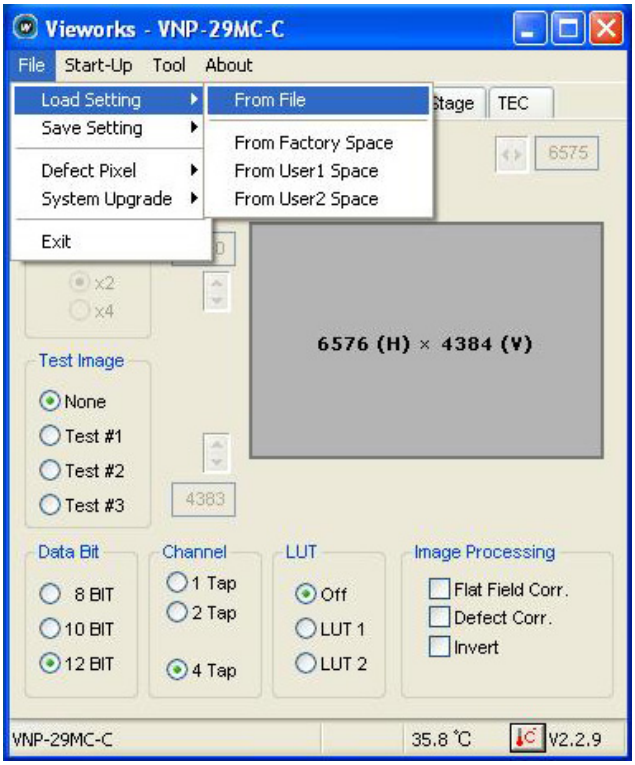


Figure 10.2 File Menu

- **Load Setting:** Loads the camera setting values from the camera memory (i.e., specified as Factory, User1 or User2) or user computer (From File).
- **Save Setting:** Saves the camera setting values to the camera memory (i.e., specified as User1 or User2) or user computer (To File).
- **Defect Pixel:** Downloads defect information to the camera (Download to Camera) or uploads defect information saved in the camera to user computer (Upload to PC).
- **System Upgrade:** Upgrades MCU or FPGA logic.
- **Exit:** Exits Configurator.

10.2.2 Start-Up

You can select the camera setting values to load when the camera is turned on.

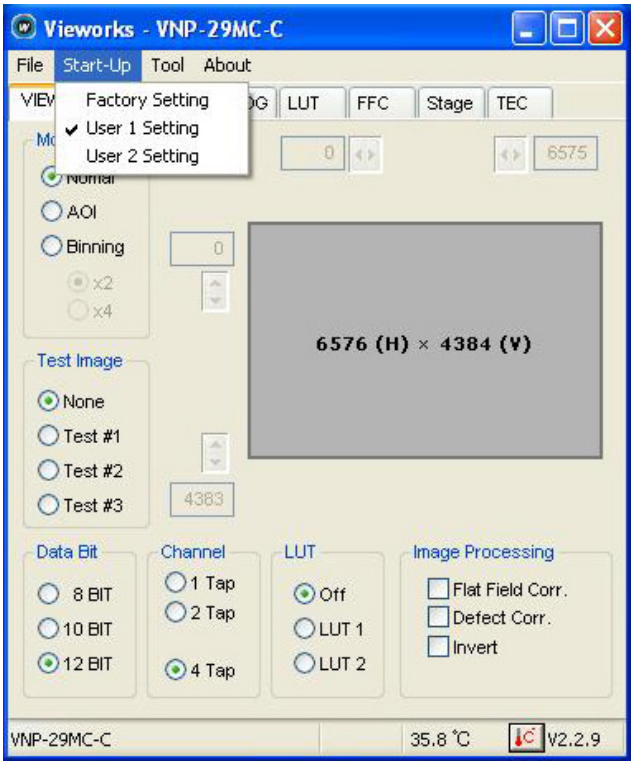


Figure 10.3 Start-Up Menu

- **Factory Setting:** Loads the camera setting values from Factory Space.
- **User1 Setting:** Loads the camera setting values from User1 Space.
- **User2 Setting:** Loads the camera setting values from User2 Space.

10.2.3 Tool

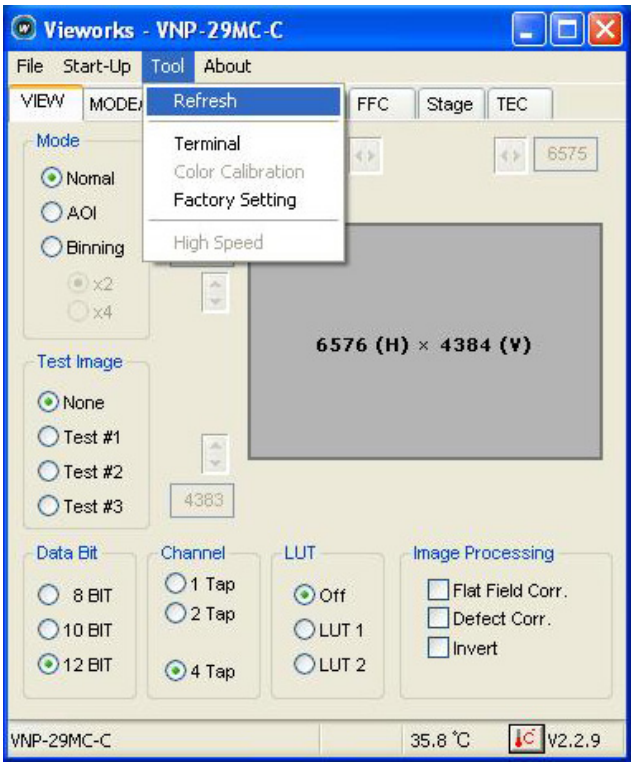


Figure 10.4 Tool Menu

- **Refresh:** Loads and displays the current camera setting values on Configurator.
- **Terminal:** Displays user commands with a Terminal window under GUI. To hide Terminal window, uncheck Terminal by clicking again.
- **Color Calibration:** Performs Bayer sensor color calibration.
- **Factory Setting:** Not supported in the user side.

10.2.4 About

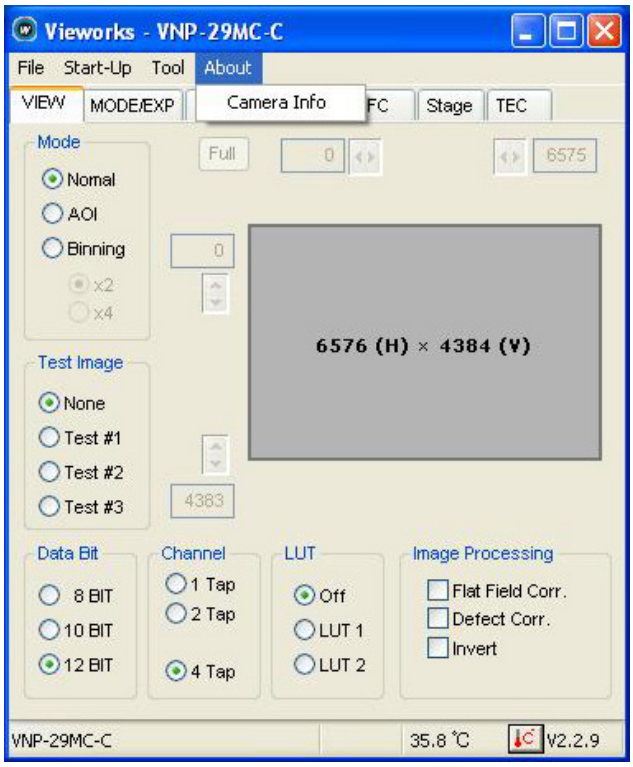


Figure 10.5 About Menu

- **Camera Info:** Displays camera information (product name, serial number, version, etc).

10.3 Tab

10.3.1 VIEW Tab

VIEW tab allows you to set the camera readout mode, test image mode, data bit, channel, LUT, image processing, etc.

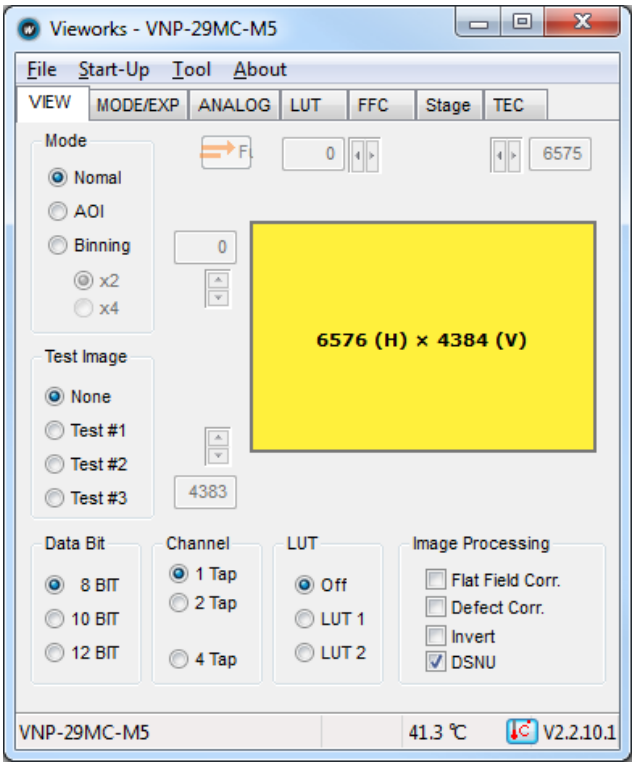


Figure 10.6 VIEW Tab

- **Mode:** Selects readout mode. If AOI is selected, AOI setting area is activated and AOI can be set by entering desired values. If Binning is selected, ×2, ×4 option buttons are activated.
- **Test Image:** Selects whether to apply test image and type of test image.
- **Data Bit:** Selects bit depth of data output.
- **Channel:** Selects channel mode.
- **LUT:** Selects whether to apply LUT and type of LUT.
- **Imaging Processing:** Sets Flat Field Correction, Defect Correction, Image Invert or DSNU features On or Off.

10.3.2 MODE/EXP Tab

MODE/EXP tab allows you to select trigger mode, exposure time and strobe. All scroll bars are controllable with the mouse wheel scroll.

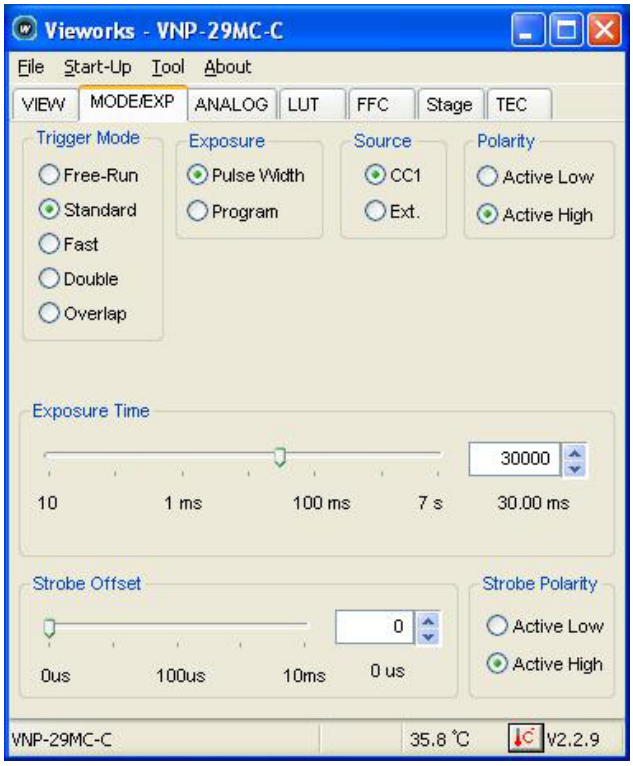


Figure 10.7 MODE/EXP Tab

- **Trigger Mode:** Selects trigger mode. Once a mode has been selected, related selections will be activated.
- **Exposure:** Selects exposure source.
- **Source:** Selects trigger source.
- **Polarity:** Selects polarity of trigger input.
- **Exposure Time:** Sets exposure time when trigger mode is set with the Free-Run mode or when Exposure is set with Program.
- **Strobe Offset:** Sets strobe offset.
- **Strobe Polarity:** Sets the polarity of the strobe output signal.

10.3.3 ANALOG Tab

ANALOG tab allows you to set gain and offset settings of the image. All scroll bars are controllable with the mouse wheel scroll.

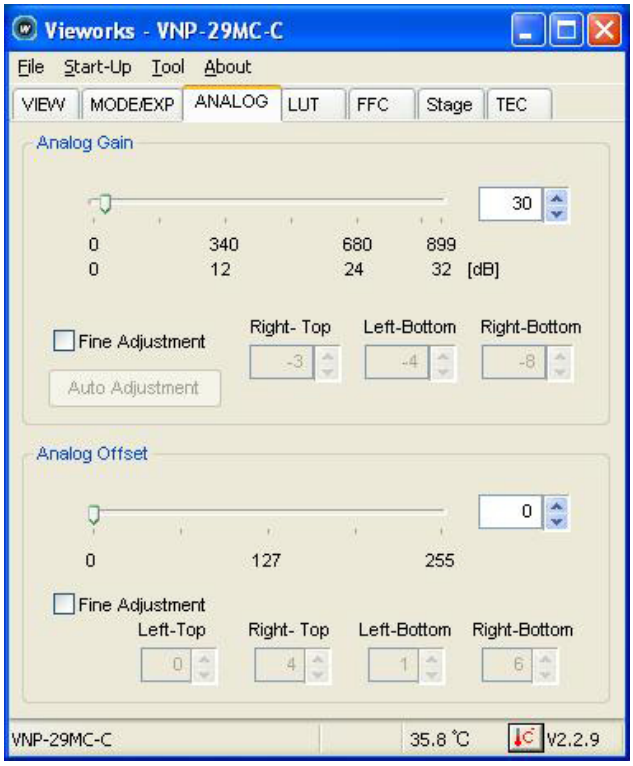


Figure 10.8 ANALOG Tab

- **Analog Gain:** Sets gain value of each channel. Checking the **Fine Adjustment** checkbox will activate the **Auto Adjustment** button. Then you can compensate Tap differences automatically by pressing the button.
- **Analog Offset:** Sets offset values for each channel.

10.3.4 LUT Tab

LUT tab allows you to download LUT data. For more information about LUT download, refer to Appendix B.

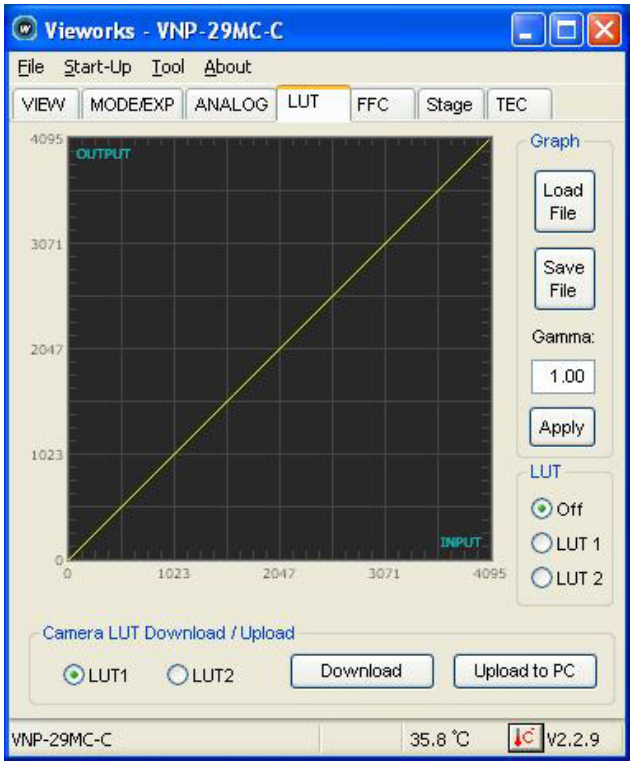


Figure 10.9 LUT Tab

- **Graph:** Loads LUT data from the user computer or sets Gamma value to be applied while using Gamma curve.
- **Camera LUT Download / Upload:** Downloads LUT data to the camera from the user computer (Download) or uploads LUT data saved in the camera to the user computer (Upload to PC).

10.3.5 FFC Tab

FFC tab allows you to set Flat Field Correction settings. All scroll bars are controllable with the mouse wheel scroll.

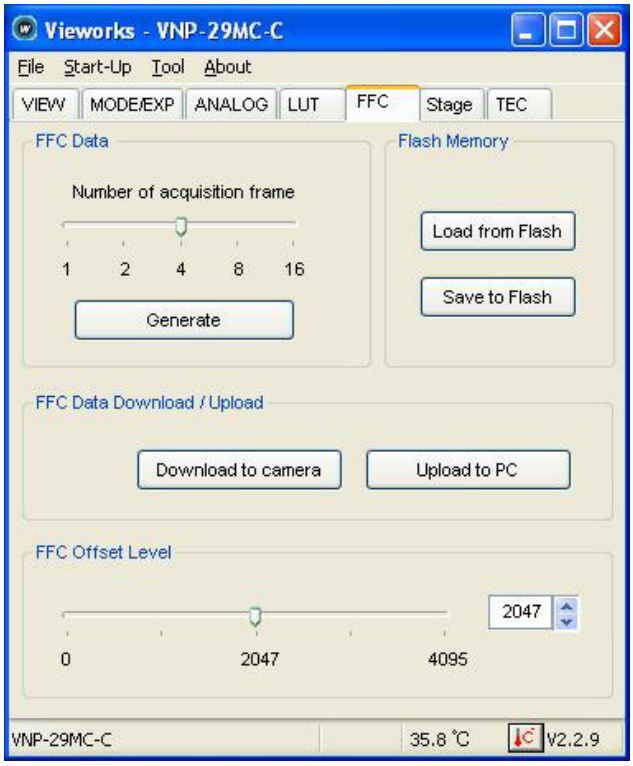


Figure 10.10 FFC Tab

- **FFC data:** Generates the FF data to be used for correction and sets how many images will be used for the generation.
- **Flash Memory:** Saves the generated FF data to Flash in order to reuse in the future (Save to Flash) or loads the saved FF data (Load from Flash).
- **FFC Data Download / Upload:** Downloads FFC Data from the user computer (Download to camera) or uploads FFC Data to the user computer (Upload to PC).
- **FFC offset Level:** Sets the offset value of the image after Flat Field Correction is applied.

10.3.6 Stage Tab

Before setting the stage, you must set MODE/EXP tab with the following values.

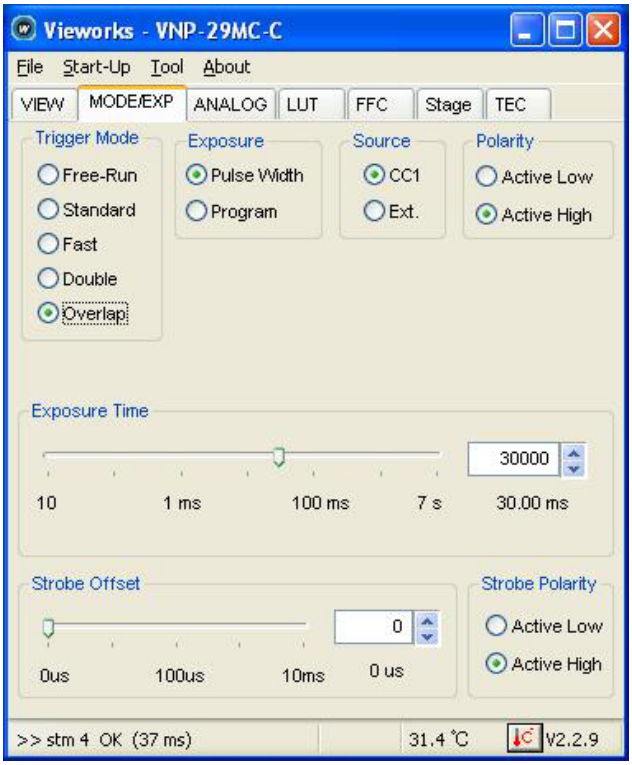


Figure 10.11 MODE/EXP settings for Nano-Stage Control

- **Trigger Mode:** Overlap
- **Exposure:** Pulse Width
- **Source:** CC1
- **Polarity:** Active High

Stage tab allows you to set Sequence Mode and Nano-Stage.

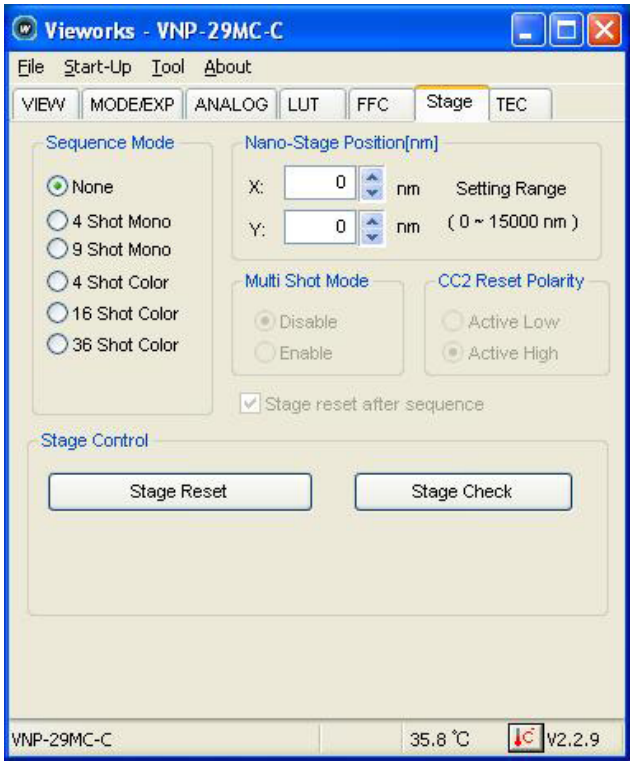


Figure 10.12 Stage Tab

- **Sequence Mode:** Selects Sequence Mode. Deactivated in the Free-Run mode.
  ex) ssm 0 ← None (Manual), ssm 1 ← 4 Shot Mono
- **Nano-Stage Position[㎚]**
  - **X:** Sets the stage position of X (Horizontal) direction (applicable range: 0 ~ 15,000 ㎚).
  - **Y:** Sets the stage position of Y (Vertical) direction (applicable range: 0 ~ 15,000 ㎚).
- **Multi Shot Mode:** Sets Multi Shot Mode.
  - **Enable:** 1 trigger N snap solution
  - **Disable:** 1 trigger 1 snap solution
    ex) sme0 ← Disable, sme1 ← Enable
- **CC2 Reset Polarity:** Sets the reset polarity using CC2.
- **Stage Reset:** Initializes the stage position and adjusts zero point of displacement sensor.
- **Stage Check:** Performs a self test of the stage.

10.3.7 TEC Tab

TEC tab allows you to control target temperature of CCD Sensor.

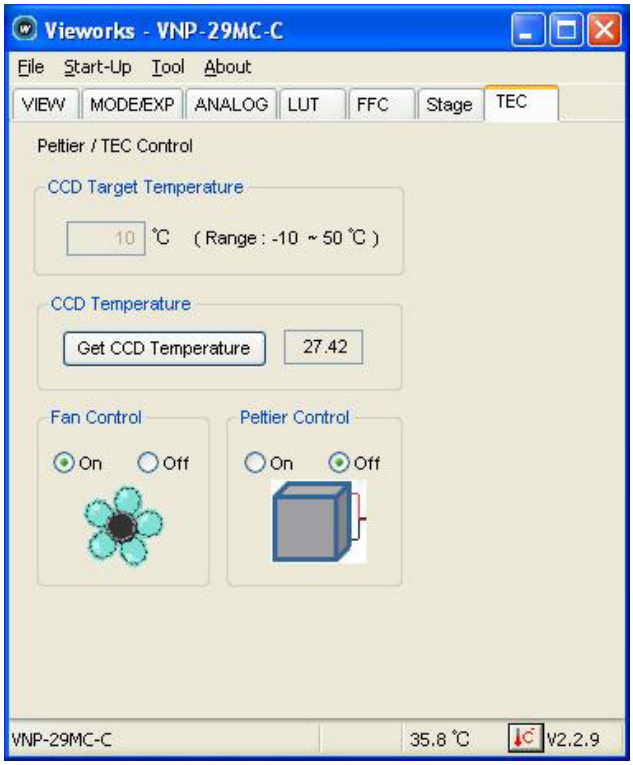
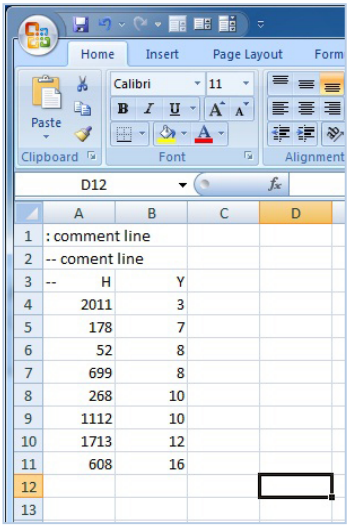


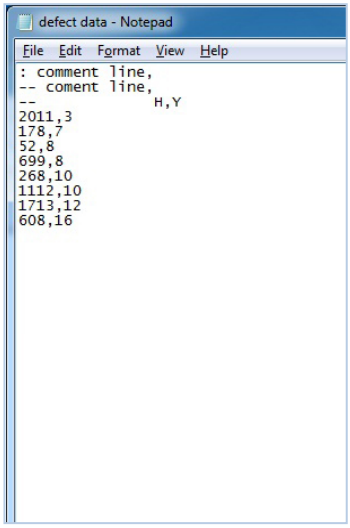
Figure 10.13 TEC Tab

- **CCD Target Temperature:** Sets target temperature of CCD Sensor.
- **CCD Temperature:** Displays CCD Sensor temperature value.
- **Fan Control:** Turns Fan On or Off.
- **Peltier Control:** Turns Peltier On or Off.

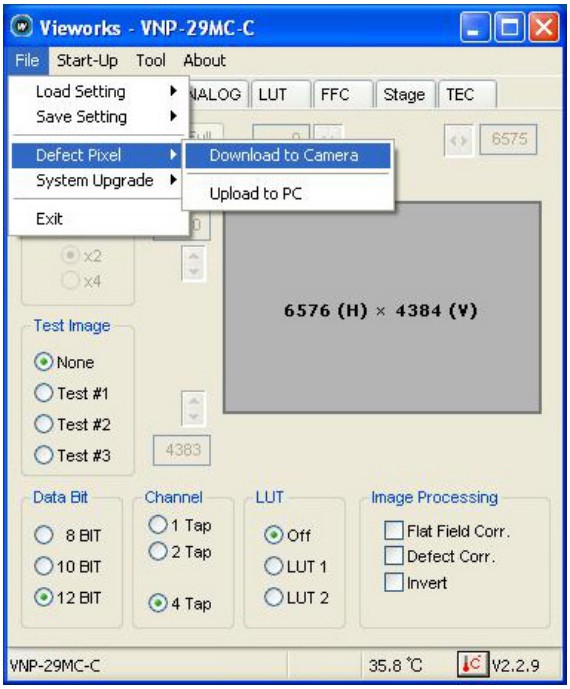
Appendix A Defective Pixel Map Download

1. Create the Defective Pixel Map data in Microsoft Excel format as shown in the left picture below and save as a CSV file (*.csv). The picture in the right shows the created Excel file opened in Notepad. The following rules need to be applied when creating the file.
   - Lines beginning with ':' or '—' are treated as notes.
   - Each row is produced in the order of the horizontal and vertical coordinate values.
   - The input sequence of pixel is irrelevant.

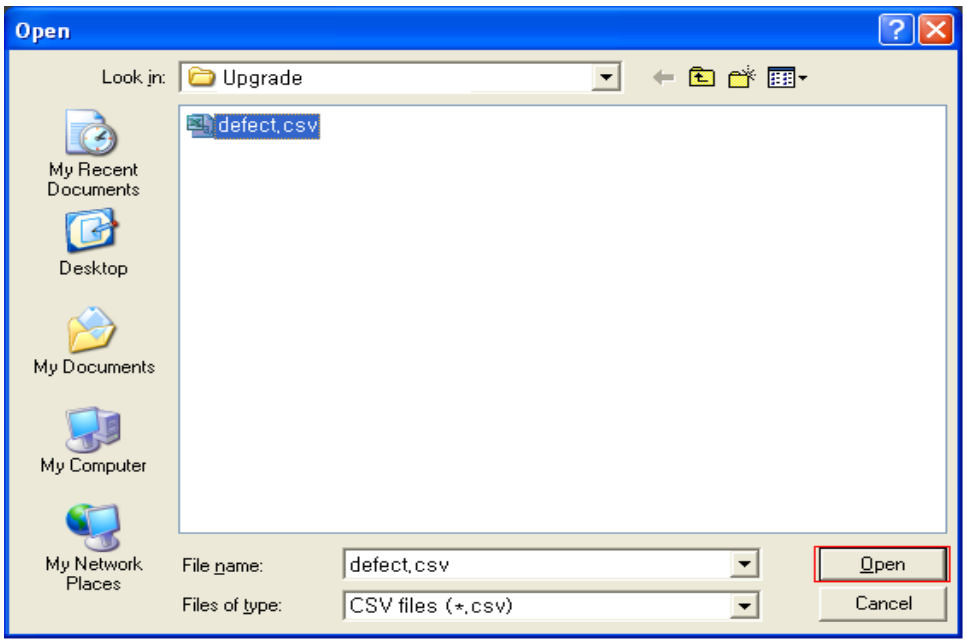




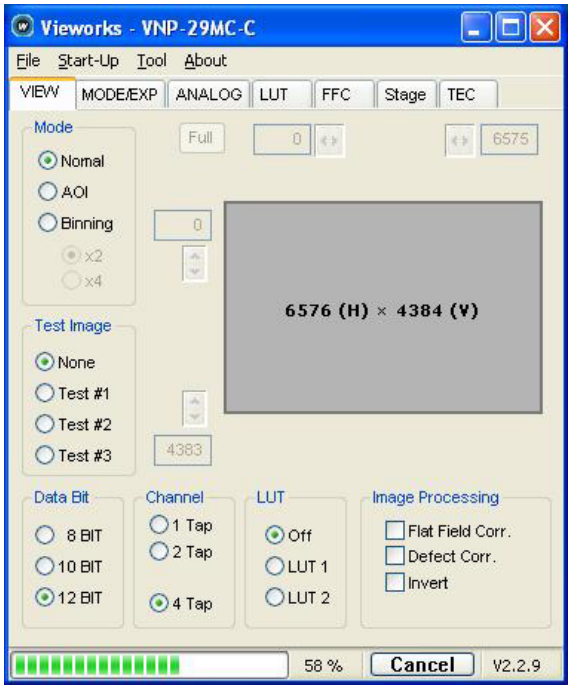
2. Select **File** > **Defect Pixel** > **Download to Camera** on Configurator.



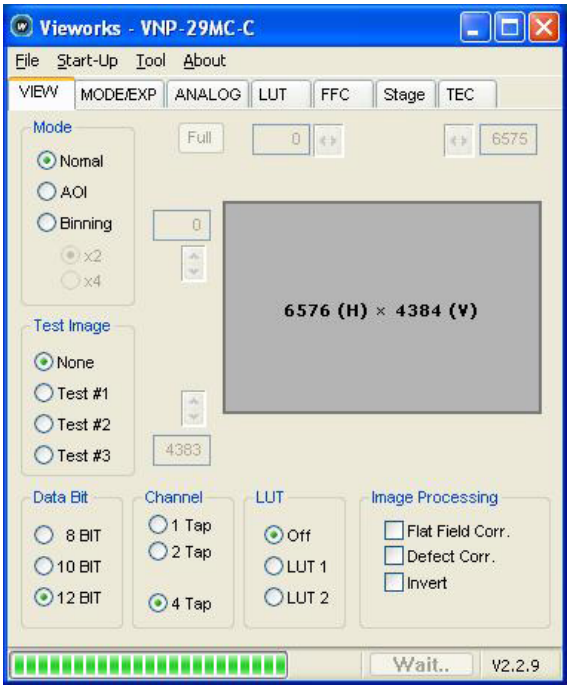
3. Search and select the created file and click **Open**.



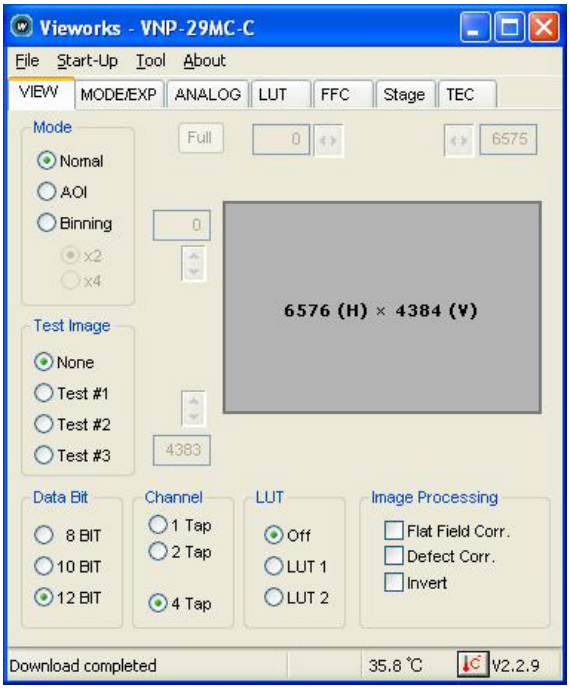
4. Configurator starts downloading defective pixel map data to the camera and downloading status is displayed at the bottom of the window.



5. Once the download has been completed, the saving process will begin. During the saving process, make sure not to disconnect the power cord.



6. Once all the processes have been completed, **Download completed** message will appear at the bottom of the window.

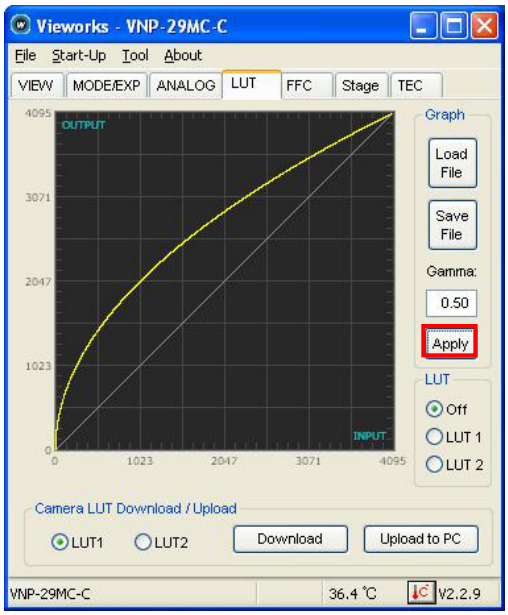


Appendix B LUT Download

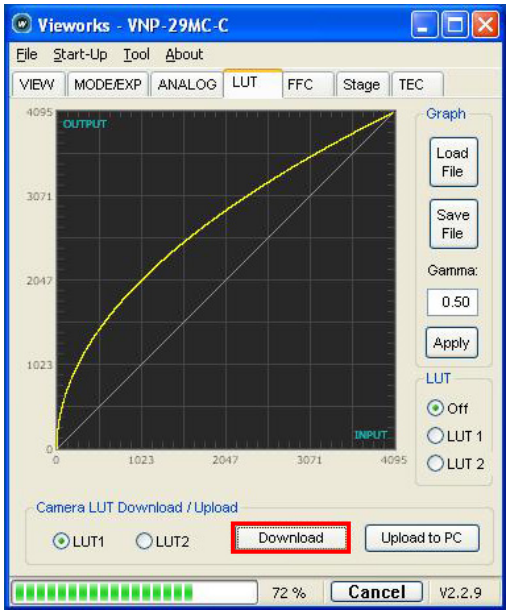
LUT data can be created in two ways; by adjusting the gamma values on the gamma graph provided in the program and then downloading the data or by opening a CSV file (*.csv) and then downloading the data.

B.1 Gamma Graph Download

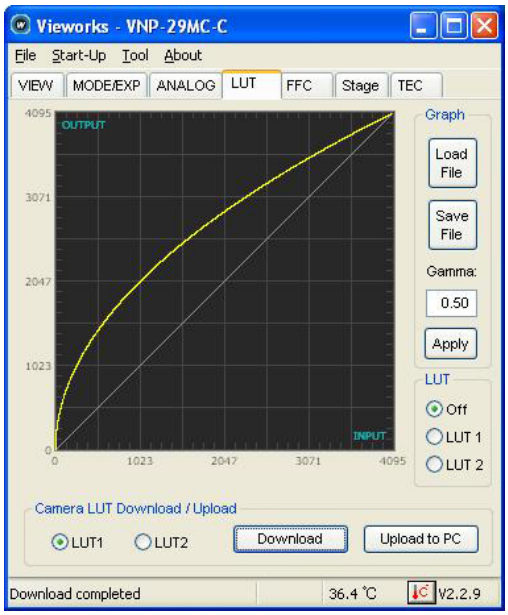
1. Set a desired gamma value on LUT tab and click **Apply**.



2. Select LUT1 or LUT2 as a location to store the data and click **Download**.

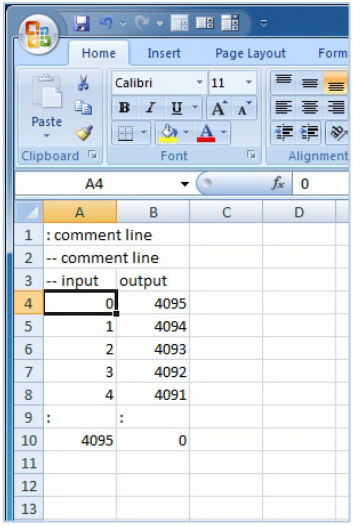


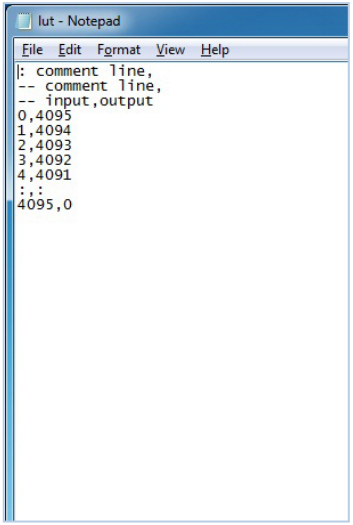
3. Once the download has been completed, **Download completed** message will appear at the bottom of the window.



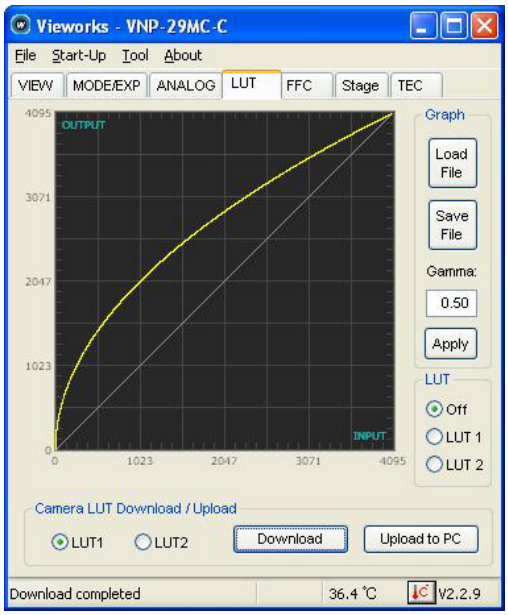
B.2 CSV File Download

1. Create the LUT table in Microsoft Excel format as shown in the left picture below and save as a CSV file (*.csv). The picture in the right shows the created file opened in Notepad. Once the file has been created completely, change the .csv file extension to .lut. The following rules need to be applied when creating the file.
   - Lines beginning with ':' or '—' are treated as notes.
   - Based on the input values, make sure to record from 0 to 4095.

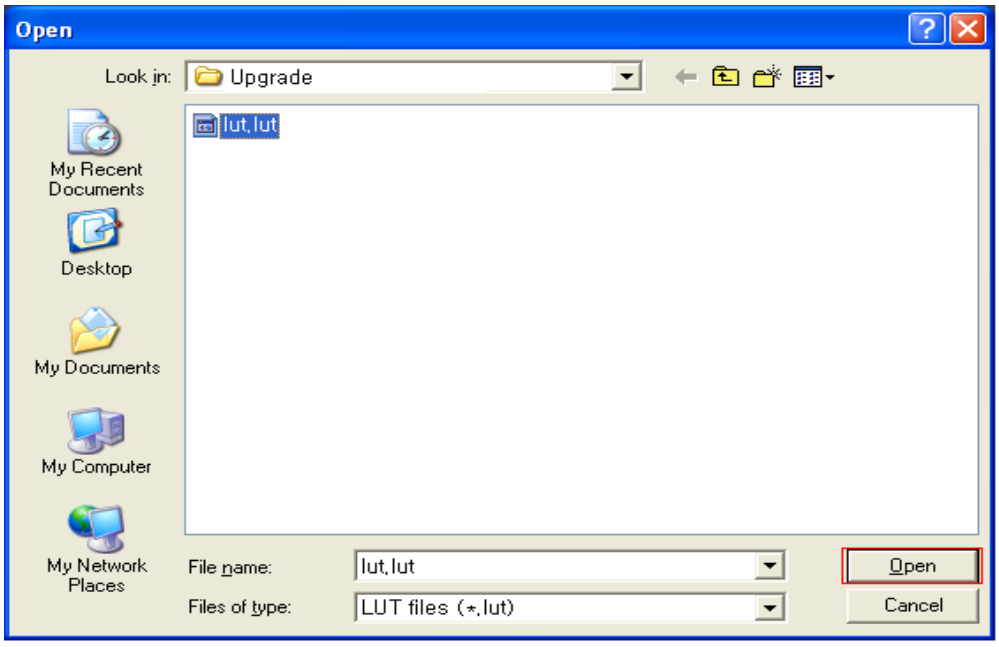




2. Click **Load File** on LUT tab.



3. Search and select the created LUT file and click **Open**.

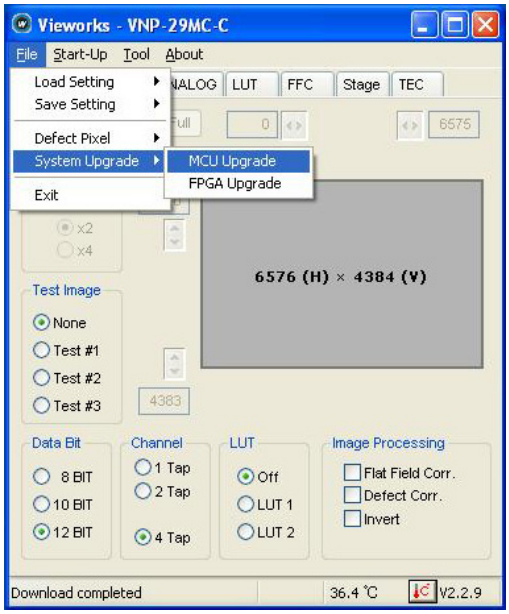


4. Select LUT1 or LUT2 as location to store the data and click **Download**. The subsequent processes are identical to those of Gamma Graph Download.

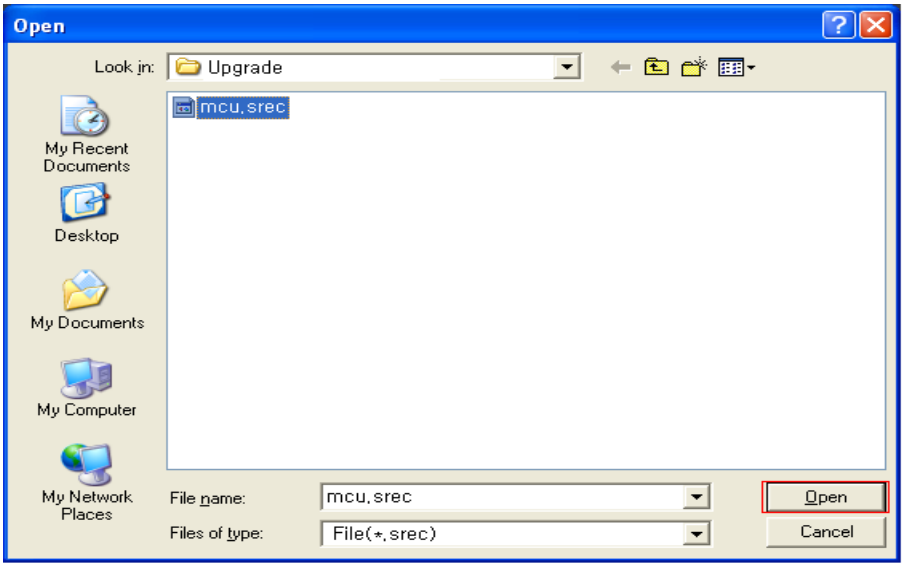
Appendix C Field Upgrade

C.1 MCU

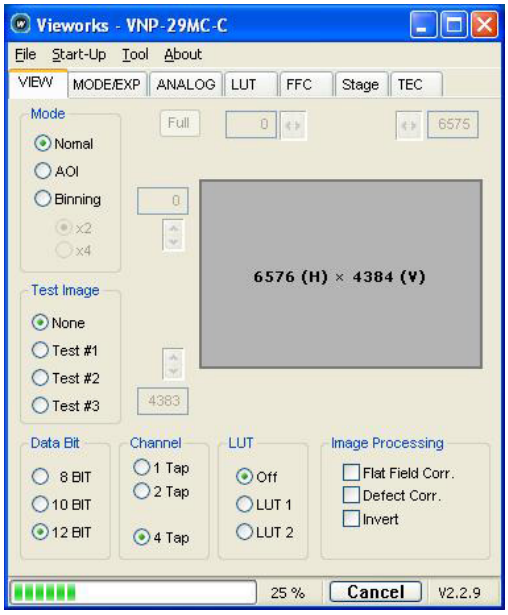
1. Select **File** > **System Upgrade** > **MCU Upgrade** on Configurator.



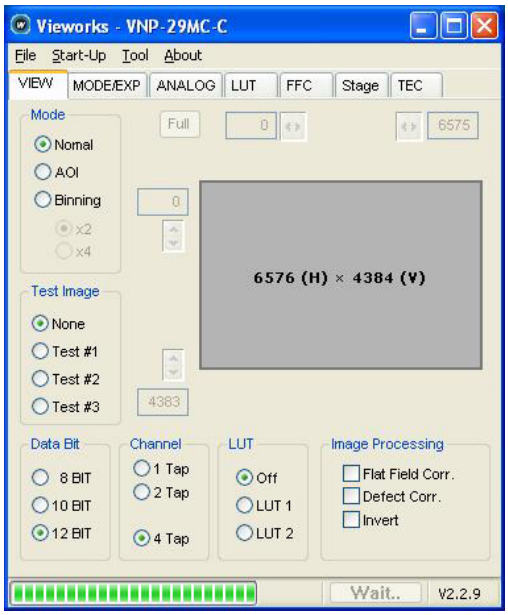
2. Search and select the provided MCU upgrade file (*.srec) then click **Open**.



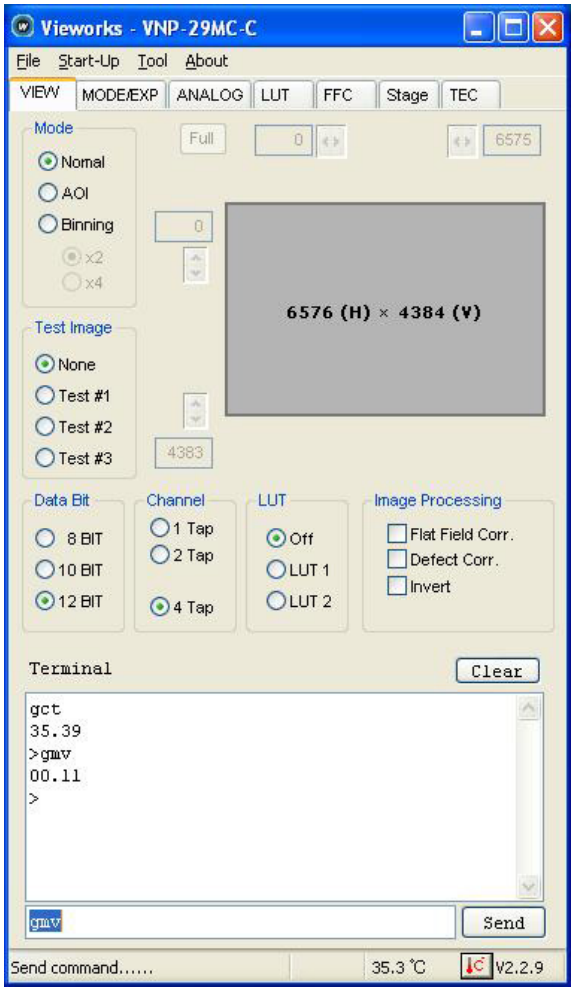
3. Configurator starts downloading MCU upgrade file to the camera and downloading status is displayed at the bottom of the window. If you want to cancel the upgrade process, click **Cancel**. This process requires several minutes to complete.



4. Once the download has been completed, the saving process will begin. During the saving process, the camera cannot be restored if a power failure occurs. Make sure that the power connection is secured.

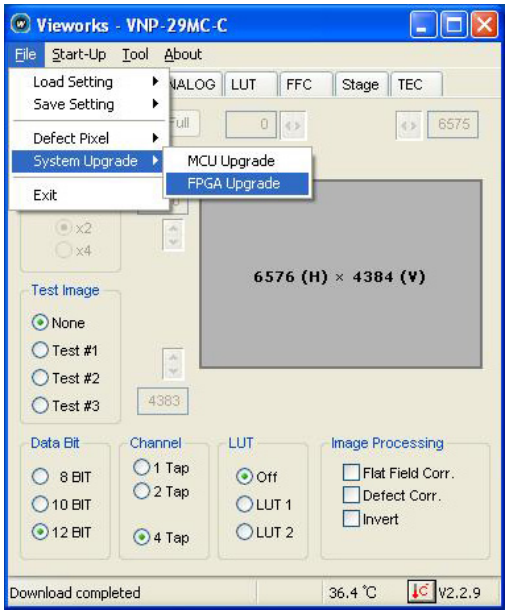


5. Once all the processes have been completed, turn the power off and turn it back on again. Select **Tool** > **Terminal** and enter the “gmv” command to confirm the version. Or, select **About** > **Camera Info** to confirm the MCU version.

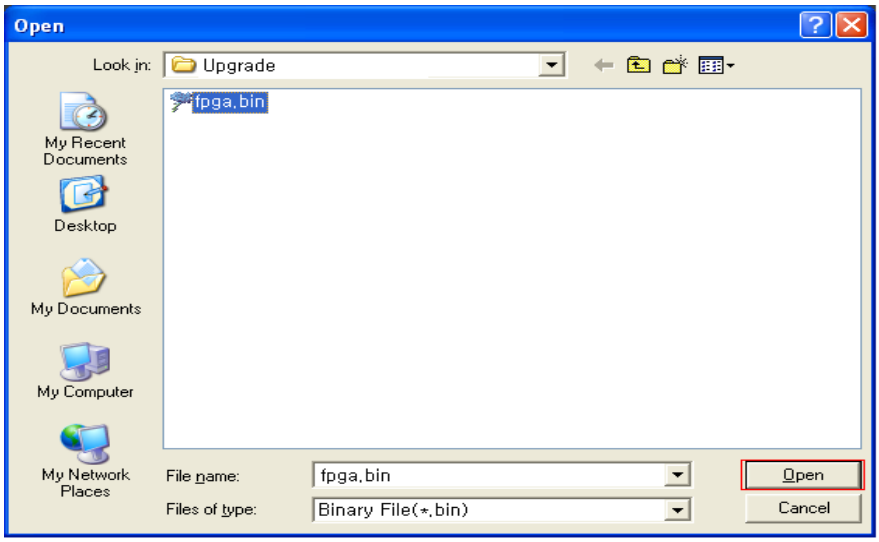


C.2 FPGA

1. Select **File** > **System Upgrade** > **FPGA Upgrade** on Configurator.



2. Search and select the provided FPGA upgrade file (*.bin) and click **Open**.

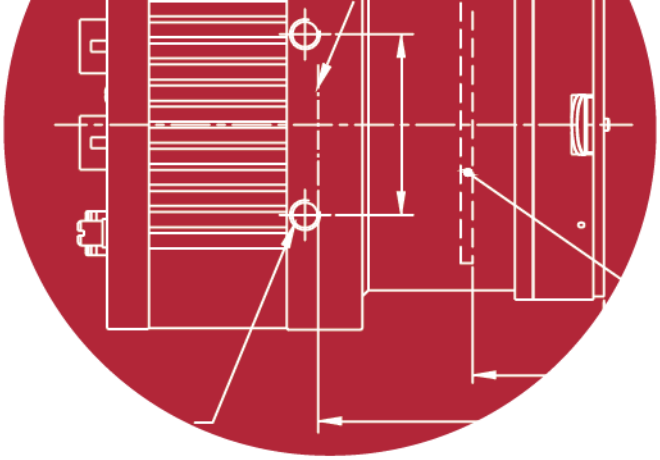


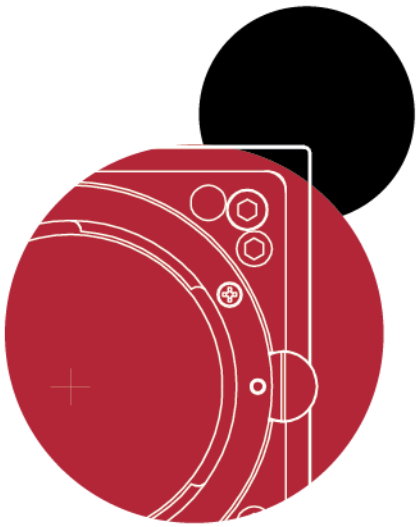
3. The subsequent processes are identical to those of MCU upgrade.

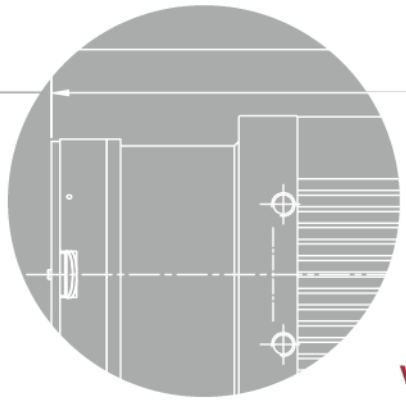
Appendix D Position settings according to sequence modes

Ratio for 1 Pixel

Order	4 Shot Mono		9 Shot Mono		4 Shot Bayer Color		16 Shot Bayer Color		36 Shot Bayer Color	
	X	Y	X	Y	X	Y	X	Y	X	Y
1	0	0	0	0	0	0	0	0	0	0
2	1/2	0	1/3	0	1	0	1	0	1	0
3	0	1/2	2/3	0	0	1	0	1	0	1
4	1/2	1/2	0	1/3	1	1	1	1	1	1
5	-	-	1/3	1/3	-	-	1/2	0	1/3	0
6	-	-	2/3	1/3	-	-	3/2	0	4/3	0
7	-	-	0	2/3	-	-	1/2	1	1/3	1
8	-	-	1/3	2/3	-	-	3/2	1	4/3	1
9	-	-	2/3	2/3	-	-	0	1/2	2/3	0
10	-	-	-	-	-	-	1	1/2	5/3	0
11	-	-	-	-	-	-	0	3/2	2/3	1
12	-	-	-	-	-	-	1	3/2	5/3	1
13	-	-	-	-	-	-	1/2	1/2	0	1/3
14	-	-	-	-	-	-	3/2	1/2	1	1/3
15	-	-	-	-	-	-	1/2	3/2	0	4/3
16	-	-	-	-	-	-	3/2	3/2	1	4/3
17	-	-	-	-	-	-	-	-	1/3	1/3
18	-	-	-	-	-	-	-	-	4/3	1/3
19	-	-	-	-	-	-	-	-	1/3	4/3
20	-	-	-	-	-	-	-	-	4/3	4/3
21	-	-	-	-	-	-	-	-	2/3	1/3
22	-	-	-	-	-	-	-	-	5/3	1/3
23	-	-	-	-	-	-	-	-	2/3	4/3
24	-	-	-	-	-	-	-	-	5/3	4/3
25	-	-	-	-	-	-	-	-	0	2/3
26	-	-	-	-	-	-	-	-	1	2/3
27	-	-	-	-	-	-	-	-	0	5/3
28	-	-	-	-	-	-	-	-	1	5/3
29	-	-	-	-	-	-	-	-	1/3	2/3
30	-	-	-	-	-	-	-	-	4/3	2/3
31	-	-	-	-	-	-	-	-	1/3	5/3
32	-	-	-	-	-	-	-	-	4/3	5/3
33	-	-	-	-	-	-	-	-	2/3	2/3
34	-	-	-	-	-	-	-	-	5/3	2/3
35	-	-	-	-	-	-	-	-	2/3	5/3
36	-	-	-	-	-	-	-	-	5/3	5/3







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